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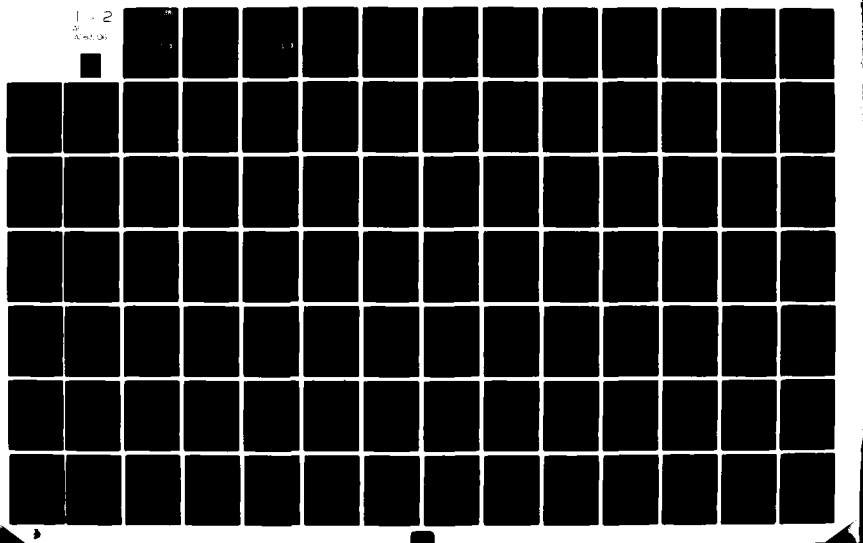

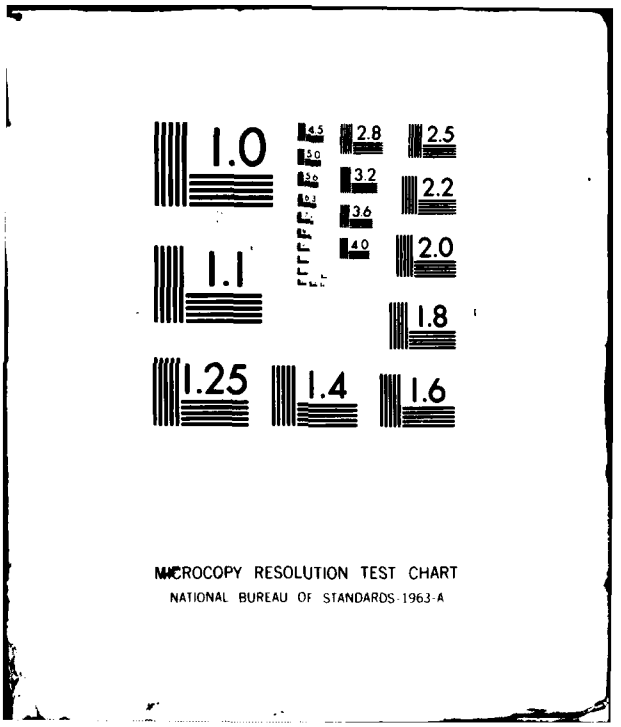
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COMPUTER PROGRAM DOCUMENTATION REQUIREMENTS
One of the Software Acquisition Engineering Guidebook Series

DIRECTORATE OF EQUIPMENT ENGINEERING
DEPUTY FOR ENGINEERING

JULY 1977

TECHNICAL REPORT ASD-TR-78-46
Final Report

AERONAUTICAL SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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(19) REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (18) ASD-TR-78-46	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (4) COMPUTER PROGRAM DOCUMENTATION REQUIREMENTS. One of the Software Acquisition Engineering Guidebook Series.	5. TYPE OF REPORT & PERIOD COVERED (9) Final Reptis
	6. PERFORMING ORG. REPORT NUMBER (14) D180-20675-1
7. AUTHOR(s) (10) W. R. Burr	8. CONTRACT OR GRANT NUMBER(s) (15) F33657-76-C-0723
9. PERFORMING ORGANIZATION NAME AND ADDRESS Boeing Aerospace Company PO Box 3999 Seattle, Washington 98124	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PE64740F (16) Project 2238 (12) 1052
11. CONTROLLING OFFICE NAME AND ADDRESS HQ ASD/ENE Wright-Patterson AFB, Oh 45433	12. REPORT DATE (11) Jul[redacted]77 / 13. NUMBER OF PAGES 112
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) UNCLASSIFIED / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

DTIC ELECTE S APR 17 1980 D B

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Software Acquisition, Acquisition Engineering, Software Documentation, Documentation Requirements, Contract Data Requirements List, Data Call, Version Description Document, Interface Design Description, Computer Program Development Plan, Computer Program Product Specification

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is one of a series of guidebooks whose purpose is to assist Air Force Program Office Personnel and other USAF acquisition engineers in the acquisition engineering of software for Automatic Test Equipment and Training Simulators. This guidebook identifies documentation requirements and describes acquisition engineering tasks associated with computer program documentation.

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FOREWORD

This guidebook was prepared as part of the Software Acquisition Engineering Guidebooks contract, F33657-76-C-0723. It identifies documentation requirements and summarizes the requirements for documentation found in Air Force regulations and specifications and augments these with Air Force experience and industry experience. Acquisition engineering tasks are defined and described for computer program documentation.

This guidebook reflects an interpretation of DOD directives, regulations and specifications which were current at the time of guidebook authorship. Since subsequent changes to the command media may invalidate such interpretations, the reader should also consult applicable government documents representing authorized software acquisition engineering processes. This guidebook contains alternative recommendations concerning methods for cost-effective software acquisition. The intent is that the reader determine the degree of applicability of any alternative based on specific requirements of the software acquisition with which he is concerned. Hence, the guidebook should only be implemented as advisory rather than as mandatory or directive in nature.

This guidebook is one of a series intended to assist the Air Force Program Office and engineering personnel in software acquisition engineering for automatic test equipment and training simulators. Titles of other guidebooks in the series are listed in the introduction. These guidebooks will be revised periodically to reflect changes in software acquisition policies and feedback from users.

This guidebook was prepared by the Boeing Aerospace Company.

This Software Acquisition Engineering Guidebook is one of a series prepared for Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson AFB OH 45433. Inquiries regarding guidebook content should be sent to ASD/ENE, Wright-Patterson AFB OH 45433. The following list presents the technical report numbers and titles of the entire Software Acquisition Engineering Guidebook Series. Additional copies of this guidebook or any other in the series may be ordered from the Defense Documentation Center, Cameron Station, Alexandria VA 22314.

ASD-TR-78-43,	Computer Program Maintenance
ASD-TR-78-44,	Software Cost Measuring and Reporting
ASD-TR-78-45,	Requirements Specification
ASD-TR-78-46,	Computer Program Documentation Requirements
ASD-TR-78-47,	Software Quality Assurance
ASD-TR-78-48,	Software Configuration Management
ASD-TR-78-49,	Measuring and Reporting Software Status
ASD-TR-78-50,	Contracting for Software Acquisition
ASD-TR-79-5042,	Statements of Work (SOW) and Requests for Proposal (RFP)
ASD-TR-79-5043,	Reviews and Audits
ASD-TR-79-5044,	Verification, Validation and Certification
ASD-TR-79-5045,	Microprocessors and Firmware
ASD-TR-79-5046,	Software Development and Maintenance Facilities
ASD-TR-79-5047,	Software Systems Engineering
ASD-TR-79-5048,	Software Engineering (SAE) Guidebooks Application and Use

TABLE OF CONTENTS

TABLE OF CONTENTS - (Continued)

TABLE OF CONTENTS - (Continued)

LIST OF FIGURES

LIST OF TABLES

Section 1.0 INTRODUCTION

Proper documentation is an essential part of the software development process. Computer program documentation is often inadequate because it is too brief or because it fails to satisfy the purpose for which it was intended. On the other hand, it may be so prolific that the intended user is overwhelmed by the magnitude of material, much of which is not needed but still purchased by the Air Force at high cost.

1.1 PURPOSE

It is the purpose of this guidebook to describe the required documents and the needs they fulfill and to provide guidelines for the acquisition engineering process, performed by the Air Force, associated with computer program documentation for automatic test equipment (ATE) and trainer simulators (TS).

1.2 SCOPE

This Software Acquisition Engineering (SAE) guidebook is one of the guidebook series related to ATE and TS ground systems. The guidebook titles in the series are as follows:

Software Cost Measuring and Reporting

Requirement Specifications

Contracting for Software Acquisition

Software Statement of Work (SOW) and Requests for Proposal (RFP)

Regulations, Specifications and Standards

Measuring and Reporting Software Status

Computer Program Documentation Requirements

Software Quality Assurance

Verification

Validation and Certification

Computer Program Maintenance

Software Configuration Management

Reviews and Audits

Management Reporting by the Software Director

This guidebook identifies documentation requirements and summarize the requirements for documentation found in Air Force regulations and specifications and augments these with Air Force and industry experience. The acquisition engineering process for computer program documentation is defined. The description of the acquisition engineering tasks for computer program documentation makes up the main body of the text.

ATE and TS documentation is traced from the Required Operational Capability (ROC), through the pre-contract planning documents prepared by the Air Force, to the documents prepared by the contractor for software development.

The guidebook is written for managers and engineering personnel responsible for the acquisition of computer program documentation. It describes the engineering tasks required in the acquisition, review and use of the software documents.

1.3 TS AND ATE OVERVIEW

This section provides a brief sketch of TS and ATE system characteristics, including the function of the computer programs associated with each.

1.3.1 TS System Characteristics

The TS system is a combination of specialized hardware, computing equipment, and software designed to provide a synthetic flight and/or tactics environment in which aircrews learn, develop and improve the techniques associated with their individual tasks in an operational weapon system. In many cases, visual and/or motion systems may be included. Figure 1.3-1 depicts a typical TS system which employs digital processing capability.

The computation system, integral to the crew training simulator, consists of one or more general purpose computers. The computing hardware consists of machines with hardware floating point arithmetic and sufficient word size and memory to provide efficient use of the simulator Higher Order Language (HOL) language.

When a multi-processor/multi-computer system is used, it must be designed such that all computers operate in parallel in real-time and are controlled and time synchronized from a single computer program supervisor/ executive. The executive directs the program execution and establishes priorities.

The simulator (1) accepts control inputs from the trainee via cockpit controls, other crew station controls or from the instructor operator station; (2) performs a real-time solution of the simulator mathematical model; and (3) provides outputs necessary to accurately represent the static and dynamic behavior of the real world system within specified tolerance and performance criteria.

Since TS are a combination of interdependent hardware and software, a joint development effort is required. As the complexity of TS increases, simulation software continues to grow in complexity, size and cost. Software costs can and do exceed computer hardware costs in many cases. Therefore, it is imperative that the simulation software acquisition engineer process be subjected to formal system engineering planning and discipline to ensure effective and efficient simulator procurement.

1.3.2 ATE System Characteristics

ATE consists of electronic devices capable of automatically or semi-automatically generating and independently furnishing programmed stimuli, measuring selected parameters of an item being tested and making a comparison to accept or reject the measured values in accordance with predetermined limits. ATE is used in place of manual devices either because it is more cost effective or the item being tested requires the speed and timing which only an automatic tester can achieve.

Figure 1.3-2 shows the typical components of an ATE system. Note that there are both hardware and software elements involved. Most of the elements shown will be found in one form or another in the majority of ATE systems.

The controls and displays section consists of the computer and peripheral devices such as control panels, magnetic tape cassettes or disks, a Cathode Ray Tube (CRT) and keyboard, and usually a small printer. The computer, as controlled by software, performs tasks like operating the peripheral devices, switching test stimuli on and off, and measuring and comparing responses of the unit under test (UUT) to predetermined values. The operator will maintain ultimate control of the testing process through some of the peripherals. However, his interaction is usually minimal since, by definition, the automatic test feature was selected in preference to an operator-controlled test system.

ATE is normally designed to allow a single configuration of ATE to be used for testing several articles of system

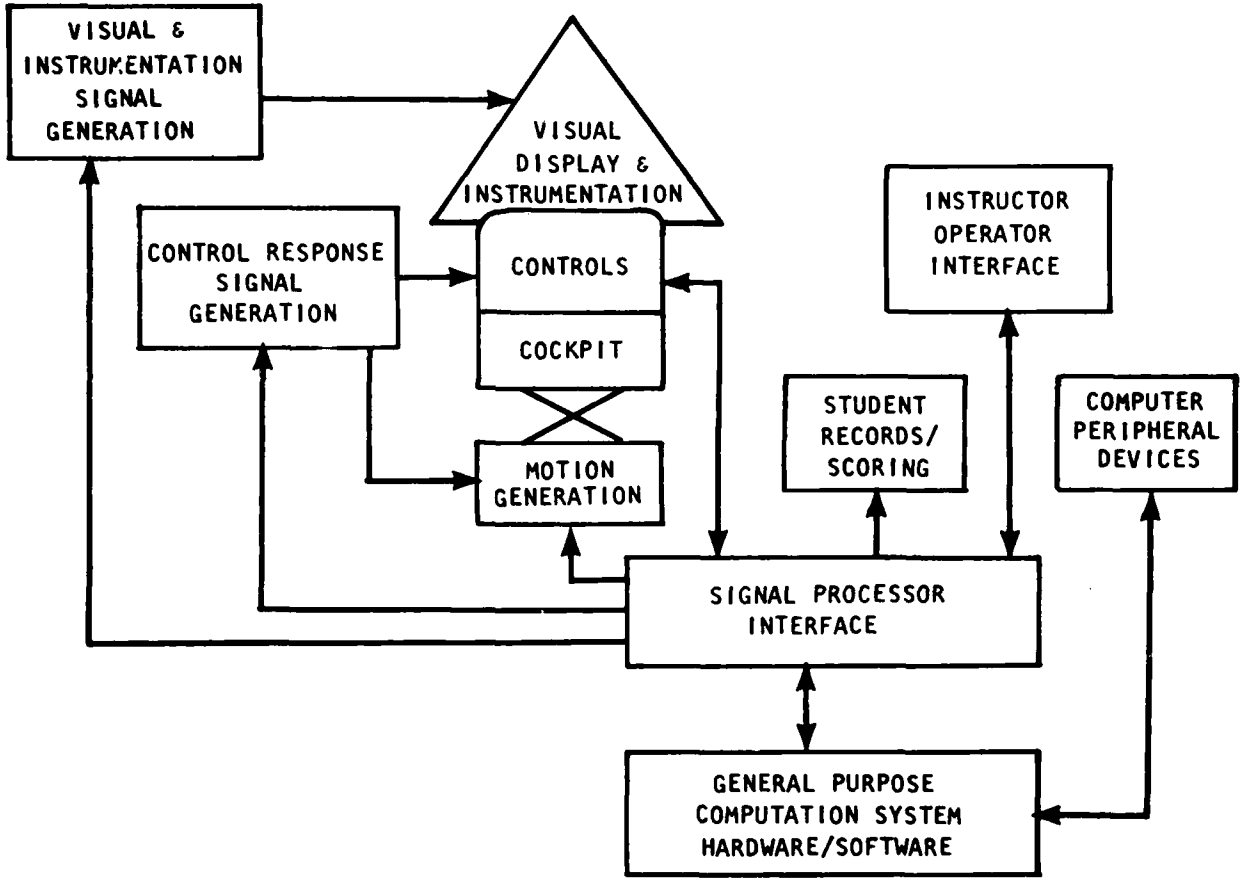

Figure 1.3-1. Typical Crew Training Simulator

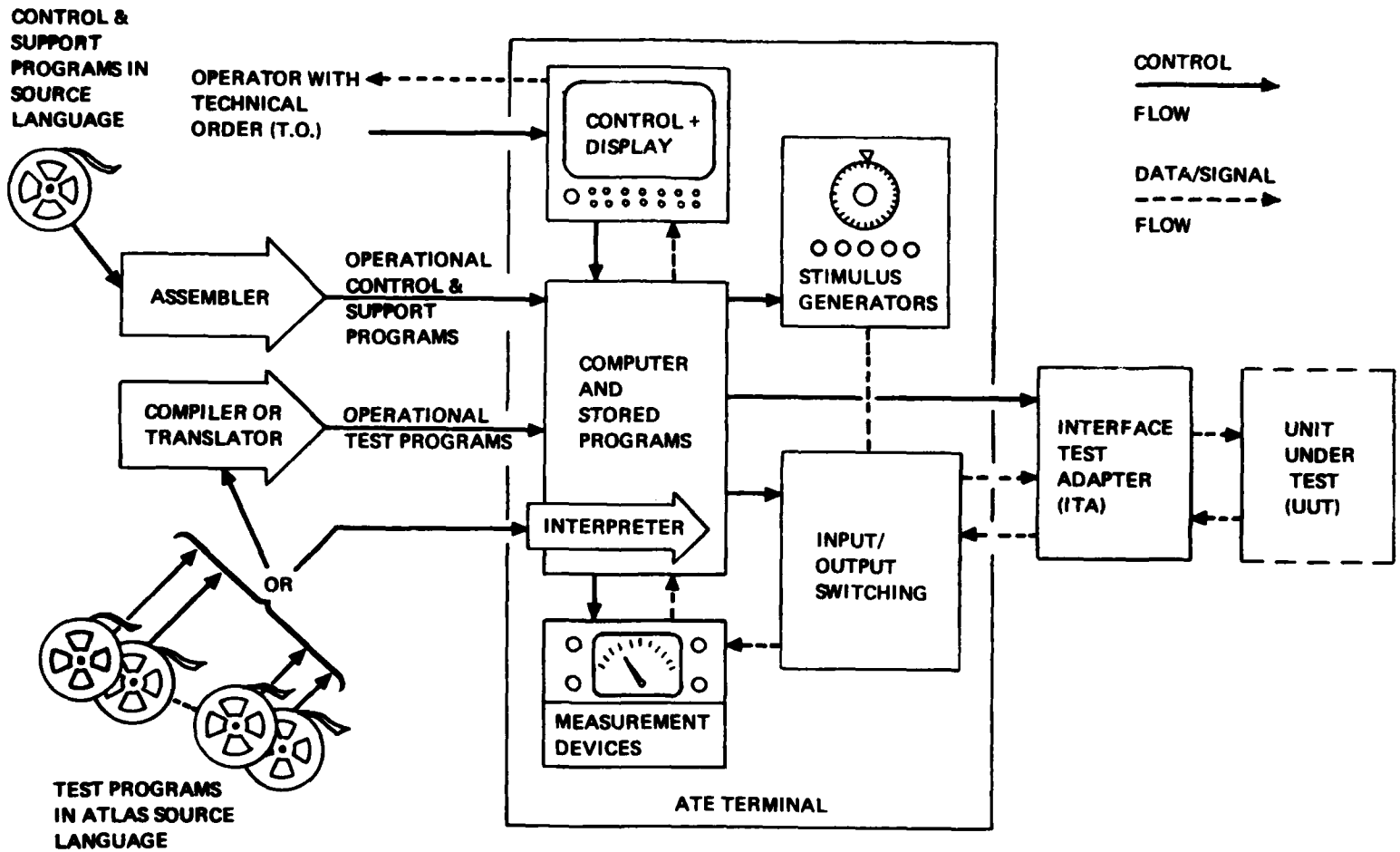

Figure 1.3-2. Typical ATE Configuration

equipment. The maintenance level being supported by the ATE is determined by logistic planning.

The importance of the software portion of the ATE system should not be minimized since both the application of the test stimuli and the measurement of the result are achieved via software. In some cases (not always) arbitrary function generation and complicated wave analysis is also accomplished by software.

1.4 GUIDEBOOK ORGANIZATION AND USE

The acquisition of computer programs for ATE and TS systems has many features that are common to the acquisition of other types of software and some features that are unique to these systems. This guidebook focuses on these unique features and the problem areas peculiar to ATE and TS systems. The more general features common to other types of software acquisition are included, but are not given the same emphasis as those unique to ATE and TS systems. A more general description of computer program documentation is given in the Electronic Systems Division (ESD) guidebook ESD-TR-76-159, Air Force Guide to Software Documentation Requirements.

The basic foundation for this guidebook is the treatment of TS and ATE software as configuration items. DODD 5000.29, Management of Computer Resources for Major Defense Systems, is explicit in specifying that computer programs are to be acquired as computer program configuration items (CPCI). The implication is that computer programs will be developed under a separate accountability and control. Computer programs will be developed to satisfy a set of written requirements that have been approved by the Air Force. The development will include specific documentation prepared during each development phase which is subject to the review of the project office. Development of software as a CPCI imposes separate configuration management controls and procedures on the acquisition process. It provides project management with visibility and control. It imposes disciplines and controls similar to hardware acquisitions. In short, it is a step to move software development from an art to an engineering process with all attendant disciplines and controls.

1.4.1 Guidebook Use

The Computer Program Documentation Requirements Guidebook is designed to be used jointly by ATE and TS acquisition engineers. This guidebook provides a description of the software acquisition engineering process as it relates to documentation. For the purpose of this guidebook, this process is defined as follows:

a. Organic preparation of documents.

b. Selection of a Contract Data Requirements List (CDRL).

c. Review and approval of requested documents produced by a contractor.

d. Document usage.

These are the activiites performed by Air Force software acquisition engineers relating to documentation in the software acquisition process. The description of these subjects is the nucleus of the guidebook. A separate section is devoted to each of the four topics.

Since the acquisition process differs for ATE and TS, some of the topics are partitioned into two sections, one for ATE and one for TS. This separation occurs in Sections 3.0, 4.0 and 5.0. It is intended that those interested in TS acquistion read the TS section and those interested in ATE acquisition read the ATE section. There are intentional redundancies within the two sections to

make each section complete and to simplify the use of the document according to the user's particular needs. The other sections of the guidebook are not separated because the subject matter is applicable to both ATE and TS disciplines.

1.4.2 Guidebook Organization

Section 1.0 of this guidebook contains introductory material about the guidebook and its relation to other guidebooks. It provides a brief description of typical ATE and TS systems and describes the organization and use of the guidebook. Section 2.0 is a list of key government documents that were referenced in the preparation of this guidebook.

Sections 3 through 7 contain documentation guidelines. Section 3 provides a discussion of the need for documentation and a summary of computer program documentation. The sequence of documents generated for ATE and TS software are described from the origin of a weapon system concept to the documents specifically produced for computer programs. Separate descriptions are provided for ATE and TS. Section 4.0 is a description of documents that are prepared by the government in preparation for a Request for Proposal (RFP). Separate sections are provided for ATE and TS. Section 5.0 is devoted to the selection of a CDRL for ATE and TS software and in essence is a recommendation for a CDRL for each. A checklist for the selection process is included. Again, separate sections are provided for TS and ATE computer progress. Section 6.0 describes the documentation provided in each computer program development phase and how the development status is related to documentation. The section also addresses the review and approval of the required documents by the Air Force, including a review checklist, and the document revision process. The documents described in Section 4.0 and 5.0 are grouped into use categories in Section 7.0 and are related to the purposes of the documentation. Section 8.0 is a bibliography of applicable material. Section 9 contains a cross reference between guidebook topics and government documents. Section 10.0, 11.0, and 12.0 provide a glossary of terms, list of abbreviations and a guidebook index, respectively.

Section 2.0 APPLICABLE DOCUMENTS

This is a list of key documents that are referenced in the text of the guidebook. The referenced documents contain material used in the preparation of the guidebook and also contain more detailed and far reaching information about the subject than can be included in this guidebook. A list of the Data Item Descriptions (DID) referenced in the text is also provided.

2.1 GOVERNMENT DOCUMENTS

AFR 310-1, Management of Contractor Data, June 1969

AFR 800-14, Vol II, Acquisition and Support Procedures for Computer Resources in Systems, Sept. 1975

DOD 5000.19.L, Acquisition Management System and Data Requirements Control List, Jan. 1977

DODD 5000.29, Management of Computer Resources for Major Defense Systems, Apr. 1976

MIL-D-83468, Military Specification - Digital Computing System for Real-Time Training Simulators, Dec. 1975

MIL-STD-483, Configuration Management Practices for Systems, Equipment, Munitions and Computer Programs, Dec. 1970

MIL-STD-1519, Preparation of Test Requirements Document, Sept. 1971

2.2 REFERENCED DIDs

DI-A-9324, Data Accession List
DI-A-5239, Computer Program Development Plan
DI-A-3108, Configurmation Management Plan
DI-#-3119A, Computer Program Development Specification
DI-E-3120, Computer Program Product Specification
DI-E-3120A/MI, Computer Program Product Specification
DI-E-3121, Version Description Document
DI-E-3122, Configuration Index
DI-E-3123, Change Status List
DI-E-3124, Specification Change Notice
DI-E-3277, Training Equipment Computer Program Documentation
DI-H-3277/M3, Training Equipment Computer Program Documentation
DI-M-5118, Computer Software Maintenance Manual
DI-M-3410, Computer Program User's Guide
DI-M-3411, Computer Programming Manual
DI-H-5070, System maintenance Programs (Software)
DI-T-3703, Category I Test Plan/ Procedures (Computer Programs)
DI-T-3717, Category I Test Report (Computer Program)
DI-T-3734, Test Requirements Document
UDI-E-695/ESD, Computer Program Development Plan
UDI-S-3911/ASD, Computer Program Development Plan
DI-E-129/M*, Computer Software/Computer Program/Computer Data Base Configuration Item(s)

* Not a document but the deliverable computer program media

Section 3.0 DOCUMENTATION SUMMARY

This section provides a summary of the documentation required in the development of ATE and TS computer programs. The need for good documentation is defined. These needs cannot be ignored particularly for TS and ATE computer programs because of long term maintenance requirements and the changing nature of the systems being simulated or tested.

The sequence of documents for both ATE and TS systems are described beginning with the original weapon system ROC and finishing with the documents prepared by a contractor to support computer program development, operation and maintenance. All documents related to wapon systems acquisition are not discussed, only those which are directly applicable or lead to significant documents in computer program development are described herein.

3.1 DOCUMENTATION NEEDS

Documentation for system acquisition programs serves many needs. These needs vary with the phase of the computer program development cycle. Each phase of the development cycle has unique characteristics that need to be documented. Figure 3.1-1 shows the type of data that is generated in each phase of the computer program development cycle. The development in each succeeding phase builds on data generated in an earlier phase; thus demonstrating the need for documenting this data as it is generated. The computer program development cycle is a repetitive process as shown in the figure. Changes, due to new requirements or design errors that occur in the operation and support phase, initate the beginning of another complete cycle culminating in the installation and operation of the revised computer programs.

Prior to the computer program development phases, system concepts, system requirements, resource allocation and plans are formulated leading to a bid package. Documentation of these efforts is essential since the quality and often the cost of the delivered computer programs is dependent on the quality of the bid package. Errors introduced at this stage are difficult and costly to remove later.

Documentation prepared in the anlaysis phase supports the definition of the functional performance requirements for a computer program. Documentation in this phase must address the allocation of requirements from system level specifications, the identification and description of interfaces and the analysis of alternate design approaches.

Documentation prepared in the design phase supports the development of the selected design approach, defining internal orogram structure and relationships and completes the detailed program descriptions. During the coding and checkout phase, the detailed design description is updated as necessary and test procedures are finalized. Computer program code is produced according to the detailed design and documented as the program listing. The individual computer program elements or modules are tested against the requirements of the development specifications and the design description in the preliminary product specification and are integrated into the complete CPCI in the test and integration phase. This process involves previously developed test plans and procedures and results in the generation of reports on the relative success of each test performed.

The installation phase requires documentation to support operation and maintenance of the software at the operational sites. Since operational sites may vary as to the particular configuration or operational requirements, tests must be

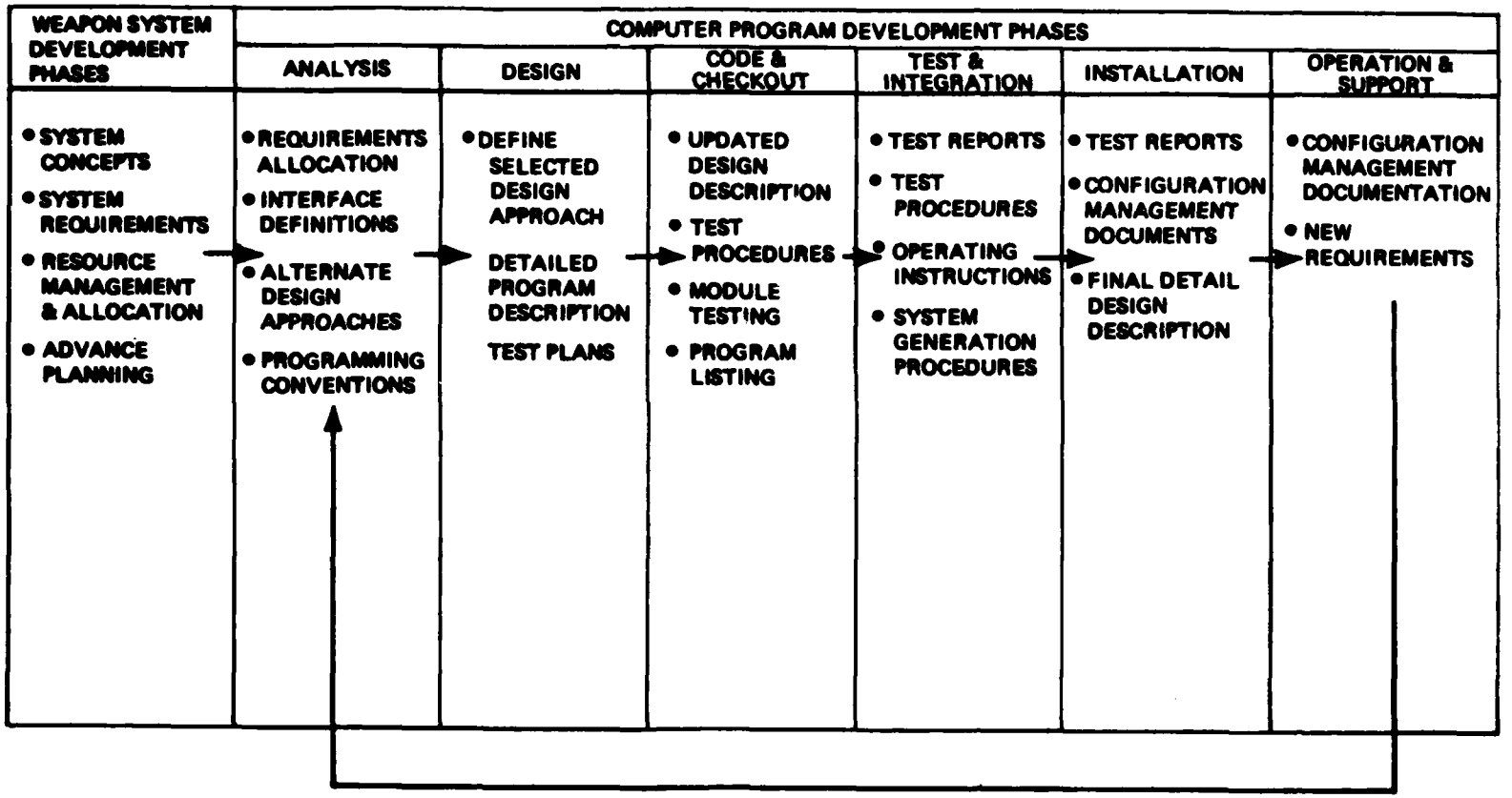

Figure 3.1-1. Documentation Needs in the Computer Program Development Cycle

performed at each site. This requires additional test procedures and reports.

In the operation and support phase, emphasis shifts to supporting the operational user via manuals and handbooks. The support aspects require documentation of the delivered software to a level that enables efficient correction of deficiencies, changes to existing software and the incorporation of new requirements. Configuration management documentation is of particular importance during this phase to ensure the exact computer program configuration is known. New requirements for changes to computer programs are documented as the basis for the beginning of a new development cycle to incorporate the changes.

As shown above, each software development phase produces some unique documentation and in turn is dependent on documentation developed during some previous phase. The following describe the specific needs for computer program documentation.

a. Provide Planning and Allocation of Computer Resources throughout the Life Cycle. Planning documentation is provided in the very early stages of system development and is the responsibility of the Air Force Commands; i.e., using, implementing and support commands, that are involved with the development, use and maintenance of the computer programs.

b. Provide a Baseline to Establish the Precise Definition of a Computer Program. The development specification provides an agreement between the Air Force and the contractor as to what a computer program must do, how well it must perform and the conditions under which it must perform. The product specification provides an exact description of the as built and delivered computer program. Computer programs are accepted or rejected by the Air Force depending on whether the functional and performance requirements are satisified and whether it has been demonstrated that the computer program code is accurately described by the product specification.

c. Provide a Means for Tracking Progress. Since unique documentation for each development phase exists, it may be used as one of the methods to track the progress of computer program development and to provide information to management (both Air Force and contractor) for visibility and decision making.

d. Provide a Means for Achieving Higher Quality Software Products. Good documentation through the development phases will aid understanding of computer program requirements, making it easier to achieve a satisfactory design. Also it will facilitate reviews of software design, test plans and test procedures and thus increase the probability of finding errors in the computer program design in all stages of development.

e. Provide an Orderly and Systematic Means of Communication at the Technical Level. When design, interface or test data are formally documented, they are available to all programmers who need that data, are easy to locate and provide a link between the programmers assigned to different parts of the program. A design that is not documented is no design at all, only a collection of one person's ideas that only he can use and are many times forgotten and lost.

f. Provide a Means for Supporting the Operation and Maintenance of a Computer Program. Good documentation is absolutely essential for efficient operation and maintenance of computer programs. Documentation generated in the development phases is the only logical source for these data. Documentation developed after the fact for operation and maintenance is often very expensive, and more

often than not, is both incomplete (lacking background data) and inaccurate.

3.2 TS COMPUTER PROGRAM DOCUMENTATION SUMMARY

The purpose of this section is to summarize the entire documentation sequence for TS computer programs and to show the relationship to the weapon systems acquisition life cycle and the TS computer program development cycle. Identification of the documents and the relative sequence in which they are produced are discussed in this section. Description of the documents are found in paragraphs 4.1 and 5.5.1.

TS computer programs have been acquired under several different types of contracts. The most common has been a separate procurement and a fixed price contract in which the entire TS system is acquired as a single configuration item. However, depending on the complexity of the systems, some of the current TS acquisitions consist of multiple configuration items including computer program configuration items. Figures 3.2-1 and 3.2-2 illustrate the documentation sequence for the separate procurement-fixed price method. The figures show the documents produced during the respective phases. Documentation sequences for other types of procurement would be similar and would probably need some slight modification. The basic documents are essentially the same, but some would require a different emphasis.

Figure 3.2-1 shows the applicable weapon system documentation sequence up to the development of a TS system. The validation, full-scale development and Production phases in the weapon system life cycle are started only when approved by the Defense System Acquisition Review Council (DSARC). Separate contracts are usually awarded for each of these three phases. The TS computer program documentation sequence is shown as a bar in the figure. This is expanded in Figure 3.2-2. It is significant to note the time delay between serious TS activity and the beginning of a weapon system acquisition. The replacement of the TS development bar in Figure 3.2-1 represents a current weapon system procurement and the current emphasis on crew training by TS systems. Some current TS contracts such as the B52 and KC135 TS systems were started well into the deployment phase and trail the acquisition of these weapon systems by many years.

Figure 3.2-2 illustrates the development phase relationship and the sequence in which specific documents are produced either directly for or in support of computer programs. Document sequence is shown only in a left-right sequence accompanied by arrowheads; vertical relationships are not indicative of sequence.

The origin of all weapon systems development projects is the ROC or an equivalent document. The weapon system ROC may call for a training capability in very general terms; thus, giving rise to the TS ROC as shown by the arrow relationship beween the weapon system ROC and the TS ROC in Figures 3.2-1 and 3.2-2. As the weapon system development continues, weapon system characteristics are defined and become the basis for the performance characteristics that will be simulated by the TS system; thus, the arrow relationship between the weapon system characteristics data and the TS documentation bar in Figure 3.2-1.

Acquisition of the TS normally originates with a TS system ROC or its equivalent. Following validation of the ROC a Program Management Directive (PMD) is published which authorizes the development of the TS system. Project planning for computer resources is documented in the Program Management Plan (PMP) and the Computer Resource Integrated Support Plan (CRISP). Documenta-

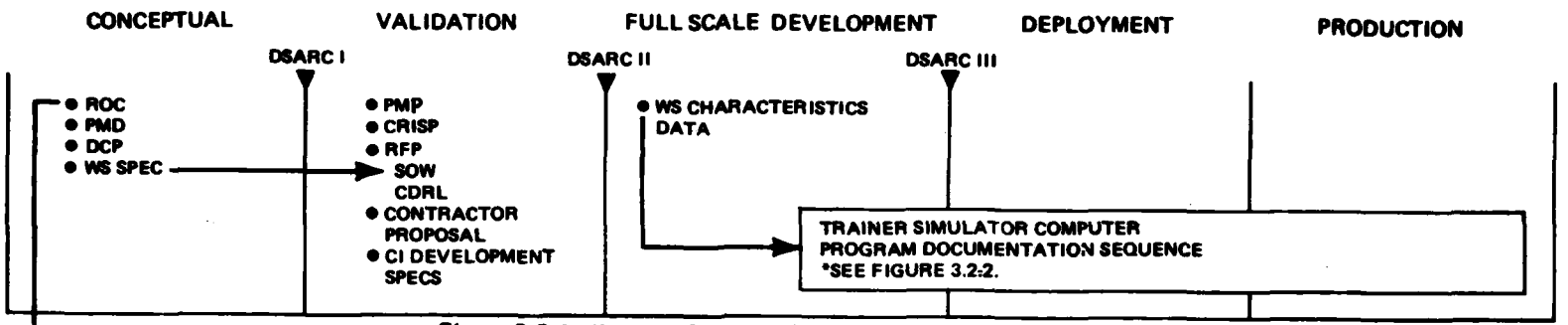

Figure 3.2-1. Weapon System Life Cycle Documentation (TS)

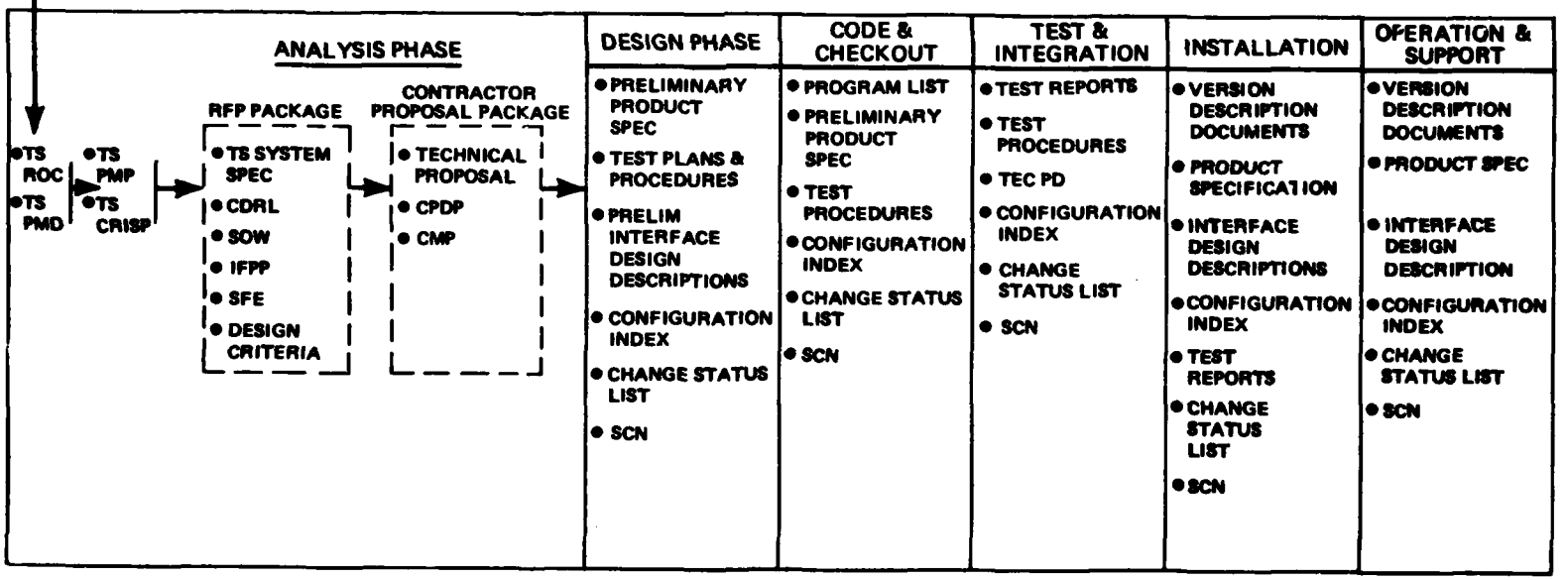

Figure 3.2-2. TS Computer Program Documentation Sequence

tion for the Request for Proposal (RFP) package is prepared and sent to prospective contractors. The RFP package includes a TS System Specification, Contract Data Requirements List (CDRL), Statement of Work (SOW), and the Information for Proposal Preparation (IFPP). Standards for Proposal Evaluation (SFE) are also prepared for government use.

Contractors prepare a proposal package which includes the technical proposal, a Computer Program Development Plan (CPDP) and a Configuration Mangement Plan (CMP). The technical proposal and the CPDP may be included as part of the contract. Up to this point there is no distinction between TS software and hardware if the TS system is acquired as a single configuration item.

The contractor will prepare some documentation unique to TS computer programs, some unique to TS hardware and some that covers the entire TS system. Documents unique to computer programs are the Computer Program Product Specification, the Training Equipment Computer Program Documentation (TECPD) and the Version Description Document (VDD). Test plans/procedures, test reports and the documents related to configuration management are written for the TS system. If computer programs are acquired as separate CPCIs, separate test plans/procedures, and test reports would be required for computer programs.

Figure 3.2-2 shows several documents repeated in successive development phases. In the case of the design documents, i.e., product specification and interface design description, preliminary release are made and updated as design changes occur in successive phases; configuration management documents, i.e., VDD, configuration index, change status list and Specification Change Notice (SCN), are initiated at their first occurrence and updated continually for the remainder of the system life cycle.

3.3 ATE COMPUTER PROGRAM DOCUMENTATION SUMMARY

The purpose of this section is to summarize the entire documentation sequence for ATE computer programs and to show the relationship to the weapon systems acquisition life cycle and the ATE computer program development cycle. Identification of the documents and the relative sequence in which they are produced are discussed in this section. Descriptions of the documents are found in paragraphs 4.2 and 5.5.2.

Computer programs for ATE have been acquired under several different types of contracts. A common method is to supplement a weapon systems contract by a Contract Change Proposal (CCP). The contract change provides for both ATE software and hardware. Alternate procurement methods have been to include ATE in the original prime contract, by Engineering Change Proposal (ECP), or to award a separate contract. Including ATE in the original contract presents special problems because at the time the contract is awarded the extent to which ATE will be used is not fully known, thus introducing an additional risk factor. The separate contract implies that a weapon system has already been developed and is in the deployment phase. In such cases, a separate contract would probably be the best approach. The separate contract would entail a process similar to the TS RFP preparation and contract response described in paragraph 3.2, with the probable exception that the contractor would provide the development specifications. After contract award the process would be similar to the one described in this paragraph. This paragraph describes the contract change approach. Documentation for the other contract types is essentially the same, but may require some slight modification.

Figures 3.3-1 and 3.3-2 illustrate the document sequence for acquisition by contract change. The figures show the docu-

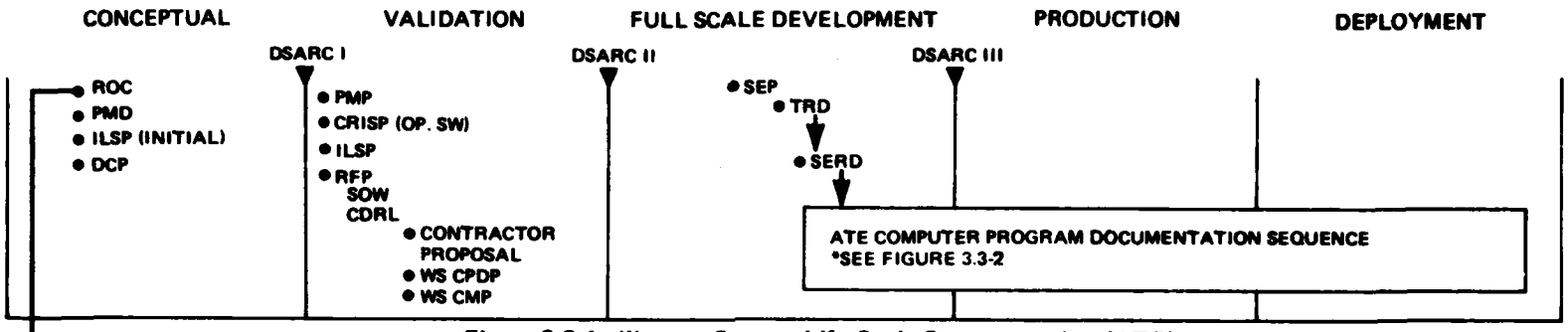

Figure 3.3-1. Weapon System Life Cycle Documentation (ATE)

ANALYSIS PHASE	DESIGN PHASE	CODE & CHECKOUT	TEST & INTEGRATION	INSTALLATION	OPERATION & SUPPORT
• CCP • SOW • CDRL • CRISP → • CPDP • DEVELOPMENT SPECIFICATIONS	• PRELIMINARY PRODUCT SPEC • TEST PLANS • PRELIMINARY INTERFACE DESCRIPTION • CONFIGURATION INDEX • CHANGE STATUS LIST • SCN • TRD (TEST SW)	• PROGRAM LIST • PRELIMINARY PRODUCT SPEC • TEST PROCEDURES • CONFIGURATION INDEX • CHANGE STATUS LIST • SCN • PRELIMINARY DESCRIPTION INTERFACE	• TEST REPORTS • TEST PROCEDURES • PROGRAMMER MANUAL • USER MANUAL • CONFIGURATION INDEX • CHANGE STATUS LIST • SCN • PRELIM PRODUCT SPECIFICATION • PRELIM INTERFACE DESCRIPTION	• VERSION DESCRIPTION DOCUMENT • PRODUCT SPECIFICATION • INTERFACE DESIGN • TEST REPORTS • CONFIGURATION INDEX • CHANGE STATUS LIST • SCN	• VERSION DESCRIPTION DOCUMENT • PRODUCT SPECIFICATION • INTERFACE DESIGN • CONFIGURATION INDEX • CHANGE STATUS LIST • SCN

Figure 3.3-2. ATE Computer Program Documentation Sequence

ments produced during each of the respective phases. Document sequence is shown only in left-right relationship; vertical relationships are not indicative of sequence.

Figure 3.3-1 shows the applicable weapon system documentation sequence up to the development of the ATE computer programs. The validation, full-scale development and production phases of the weapon systems life cycle are started only when approved by the DSARC. Separate contracts are usually awarded for each of these three phases. The ATE computer program documentation sequence is shown as a bar in the figure. This is expanded in Figure 3.3-2. It is significant to note that there may be a significant time delay between the beginning of the weapon system acquisition process and the ATE acquisition activity. The replacement of the ATE development bar in Figure 3.3-1 reflects a current weapon system procurement in which ATE activity was started late in the development phase which is several years after award of the prime contract. For any given system the bar may move either right or left. Indeed, some current weapon system programs are considering ATE requirements prior to issuing an RFP. This approach has merit because it involves ATE planning early in the program but also has the disadvantage that insufficient information may be available at this time to completely define ATE requirements. As stated earlier, ATE has also been acquired after a weapon system has been deployed. Figure 3.3-2 illustrates the ATE computer program development phase relationship and the sequence in which the documents are produced either directly for or in support of computer programs.

It is very difficult to determine detailed support equipment requirements if the early planning is usually delayed for a considerable time after the initial weapon system planning. The delay is the source of many problems in planning for ATE computer programs. Figure 3.3-1 shows the documents developed for the weapon systems. The initial formal documentation is a ROC. The Weapon System ROC normally specifies in very general terms; e.g., that support equipment is required to provide weapon systems maintenance. After the ROC is validated a PMD is released authorizing further program planning and competition for funds.

A SPO cadre is formed and a study effort is initiated to determine the various means of satisfying the ROC and PMD requirements. A Development Concept Paper (DCP) is prepared and is sent to the DSARC along with the initial Integrated Logistics Support Plan (ILSP). Based on approval of the DCP and budget authorization, the acquisition process is underway.

The CRISP, the PMP and the ILSP are early program planning documents that affect ATE computer programs. These documents lead to a weapon system RFP that is sent to prospective contractors. The RFP package is similar to the one described for TS systems in paragraph 3.2. Particular significance in the RFP package is the SOW and the CDRL.

The SOW may require a CPDP and a CMP to be submitted with the contractor proposal. This CPDP is normally written for the weapon system operational and support computer programs and usually does not specifically include computer program development and configuration management techniques described in the weapon system documents that are applicable to ATE. The CMP is important at this stage because configuration management requirements must be specified for ATE computer programs, even at this early time.

Serious planning for ATE begins after the weapon systems contract is awarded and the contractor begins planning for support equipment. It is noted that most

of this planning is a contractor task. The Integrated Support Plan (ISP), Support Equipment Plan, and the Support Equipment Recommendation Data (SERD) documents lead to the requirements for ATE computer programs and the eventual contract addition for ATE. The arrowhead from the SERD to the ATE development bar indicates this relationship. It should be noted that the Test Requirements Document (TRD) is usually prepared by the developer of the units to be tested who may be the weapons system contractor or a subcontractor. In either case the unit developer will probably not be directly associated with the ATE software organization. The TRD is the basis for the development specification for ATE test software. This is indicated by the arrowhead from the TRD to the ATE development bar. Preliminary TRD data is also used in the analyses that result in the SERD.

Paragraph 3.3-2 defines the computer program development phase sequence of the documents required specifically for ATE computer program acquisition. A CCP is prepared to amend the contract. A separate SOW is prepared to define the ATE engineering tasks to be added to the prime contract.

During negotiation for the addition to the contract, a CDRL is established or a revision is made to the weapon system CDRL. ATE computer programs are separated into three categories: test software, which controls the actual testing functions; control software, which includes executive, I/O drives, storage and retrieval, and data processing tasks; and support software that includes compilers, assemblers, loaders and system generation programs. All three classifications are CPCI.

Since the original CRISP covers a much broader scope and is prepared for in advance of the ATE acquisition, a separate CRISP for ATE is preferred. Thus, computer resource planning for ATE is accomplished with ATE as the principle subject. The CPDP is specified in AFR 800-14, Volume II, as a requirement for all CPCIs. Development specifications for the computer programs are generated during the Analysis Phase. Again the TRD plays a key role that is discussed more thoroughly in paragraphs 5.5.2.1.2 and 5.5.2.1.3.

Figure 3.3-2 shows the progression of the product specifications, interface design documents, test plans and test procedures, programmers manual, user guide, VDD, configuration index, change status list and SCN. The figure shows several documents repeated in successive development phases. In the case of the design documents preliminary releases are made and updated as design changes occur in successive phases; test procedures are developed for succeeding higher level tests; i.e., module tests, CPCI tests, ATE level tests, installation, etc.; configuration management documents, i.e., VDD, configuration index, change status list and SCN, are initiated at the first occurrence and updated as changes occur for the life of the program.

Section 4.0 GOVERNMENT PREPARED DOCUMENTS

During early planning and pre-RFP phases in a weapon systems procurement, the Air Force produces a number of documents that lead to the acquisition of TS and ATE computer programs. These early planning documents are primarily devoted to the weapon system and in fact may contain very little, if any, specific references to ATE and TS. This section will deal with the documents prepared by the Air Force with direct application to the eventual acquisition of TS and ATE. TS and ATE are normally acquired by different contracting methods.

TS are often acquired as a separate fixed price contract. The development of TS systems is not always performed by the weapon system contractor. A number of contractors specialize in the building of personnel training systems. Since development of a TS system usually does not occur until late in the Full Scale Development phase, TS system requirements can be defined to a satisfactory degree to permit fixed price contracting. However, methods other than fixed price are also being employed. These methods generally involve a separate contract and are not part of a weapon system contract.

ATE is usually acquired by negotiating a supplemental agreement to a weapon system contract. Other methods are also used such as including ATE in the initial weapon system contract or under special circumstance awarding a separate contract. A separate contract is usually awarded when development has been completed and the weapon system already deployed. Usually ATE is provided by a weapon system contractor because the task is integral to the development of the components to be tested, testing those components in prototype system and providing for efficient maintenance and support in the development phase.

Since acquisition methods differ considerably, this section is divided into separate sections for TS and ATE. While essentially the same documents are produced at some stage in the process, there is a significant difference in emphasis and tasks performed by ATE and TS engineering personnel.

4.1 TRAINER SIMULATOR DOCUMENTS

The Air Force prepared documentation is similar to that for a weapon system procurement with a ROC, PMP, CRISP and preparation of an RFP. The emphasis is on documentation for establishing a TS program, program planning and the formulation of a bid package supported and prepared by TS engineering. Figure 4.1-1 shows the relationship of government prepared documents leading to the RFP and the eventual proposal evaluation.

Since TS systems are normally acquired under a separate contract, the RFP package will be generated specifically for the trainer simulator system and will require significant activity from the TS engineering support organizations. Engineer support will also be provided for the early program requirements and planning documents such as the ROC, the PMD and the PMP. The following paragraphs describe the generation of these documents including who prepares them, where they fit in the weapon system life cycle and what responsibilities are fulfilled by the engineering support organization.

4.1.1 Required Operational Capability

The ROC is a formal document used to identify an operational need and to request a new or improved capability for the operating forces. It is prepared in accordance with AFR 57-1, Required Operational Capabilities. In the case of a TS system ROC, it specifies the need for a capability for training and evaluation activities to support an Air Force weapon system program. The training capability sought is described in terms of the need, the capability, the opera-

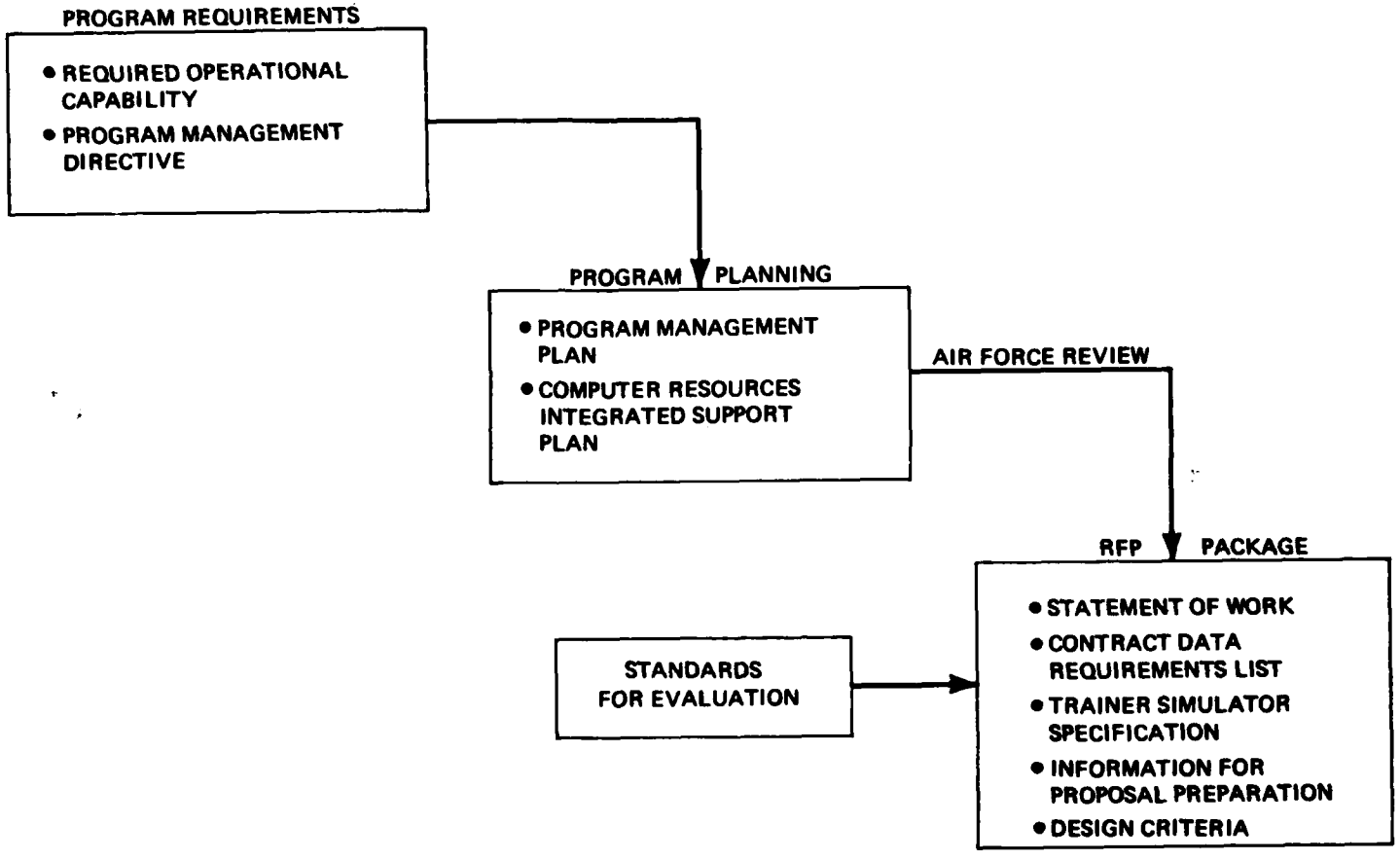

Figure 4.1-1. TS Government Prepared Documents

tional environment, support and maintenance concepts, concept of operations and the preferred solution and alternatives. Upon validation the ROC is permitted to compete for funds and resources within the context of total Air Force requirements, priorities and objectives.

At least two ROC's will be published that relate to the TS systems. The weapon system ROC is published at the outset of a weapon system acquisition. It will contain at most only a recognition that a training capability must be provided to support the weapon system. It may or may not specify any greater detail. In either case the reference is very general will not require any significant engineering action other than a cursory examination to ensure that a training capability is identified.

Preparation of the TS ROC is normally begun after development of a weapon system is in progress. In some cases the TS ROC may be generated years after the weapon system has become operational such as the B-52 and KC-135 systems. In current systems it is desired that the training capability will be available at the time the weapon system becomes operational. To place the TS ROC in the perspective of the weapon systems' life cycle, at least for current weapon systems, the ROC is initiated during either the later full-scale development phase or the production phase; in either case it is after a decision to enter the production phase (see Figure 3.2-1). The TS ROC is initiated by the using command when the need is identified. When requested by the originator, simulator engineering personnel assist in generating the ROC. Engineering should be prepared to assist in determining budgetary cost information and proposing alternative solutions, for satisfying the ROC. Three alternatives are desired keyed to the concept of minimal, operational and expanded performance.

a. Minimum-Essential Performance Characteristics,

b. Optimum Performance Characteristics (or preferred), and

c. Expanded Performance Characteristics (expanded characteristics for enhancement of effectiveness, efficiency and utility.)

Prior to publication of the ROC the originator will forward draft copies to commands having mission responsibility. Air Force Logistics Command (AFLC) and Air Force Systems Command (AFSC) will review the drafts. Engineering will participate in the review, providing comments and recommendations as necessary.

Whether engineering participation involves participation in the preparation of the ROC or in reviewing the proposed ROC, emphasis should be on expressing the operational requirements rather than describing the technical approach. It is often easy to get carried away into the technical approach to the problem rather than digging out the required characteristics of the TS systems. The effort spent on this effort early in the acquisition process may have a significant effect on the ease of achieving the required capability and on the final product.

4.1.2 Program Management Directive

Following the validation of a ROC by HQ USAF, the Air Staff publishes a PMD authorizing the development of the TS system, thereby initiating the TS project. The PMD is written for the TS system in accordance with AFR 800-2, Acquisition Management. The PMD documents the validation of the ROC program decision, significant tasking of major commands and direction and guidance on the expenditures of funds. It also directs that plans be prepared for managing computer resources. The major computer resource planning documents are the PMD, the PMP, the CRISP and the CPDP. The PMD is concerned with the identification of computer resources and the technical and managerial expertise for managing the acquisition of TS sub-

systems. This includes management expertise to focus attention on TS computer program development and integration across the total TS system.

Normally there is little or no engineering participation in writing the PMD. However, there is some precedent for engineering participation in its preparation. The Air Staff may request assistance ranging from full participation to responding to specific questions for a PMD written for a TS system. TS engineering should be prepared to provide assistance upon request.

4.1.3 Program Management Plan

The PMP is written for the entire TS system based on the policies of AFR 800-2, Acquisition Management and AFR 800-14, Volume II. It includes complete training for the acquisition management of TS computer resources. It provides a requirement for a CRISP to be prepared, Between the PMP and the CRISP, planning for complete acquisition management and technical support of computer resources are provided over the entire TS life cycle.

Preparation of the PMP is the responsibility of the TS program manager. Since it is one of the major computer resource documents, TS software engineering personnel will participate in the preparation of the PMP. TS engineering will provide the technical expertise for planning the acquisition management of computer resources. The parts of the PMP that are concerned with computer resources are specified in AFR 800-14, Volume II, Acquisition and Support Procedures for Computer Resource in Systems. Since the PMP is binding on all participating organizations, it is essential that the PMP receives a meaningful review from all affected organizations; e.g., the using, implementing and support commands, before its publication to ensure a meaningful document.

4.1.4 Computer Resources Integrated Support Plan

The CRISP identifies organizational relationships and responsibilities for the management and technical support of computer resources and is prepared with the guidelines specified in AFR 800-14, Volume II. It functions during the full scale development phase to identify computer resources necessary to support computer programs after transfer of program management responsibility and system turnover to the using command. It continues to function after the transfer of program management responsibility and system turnover as the basic agreement between the supporting and using commands for management and support of computer resources.

The CRISP is written as a part of and in parallel with the PMP. The CRISP is prepared by a Computer Resources Working Group (CRWG). The CRWG consists of representatives of the implementing, supporting and using commands to ensure that necessary elements of the CRISP are included in transfer and turnover agreements. The CRISP and its periodic updates are the responsibility of the program manager and must be approved by him. The CRISP is developed during the analysis phase of a TS system acquisition (prior to the RFP) and remains a viable document throughout the TS system life cycle. The CRISP is updated as necessary to reflect changes in computer resource requirements.

TS engineering personnel will be represented on the CRWG. During the initial formulation of the CRISP, it is important that all affected commands are fully prepared to spend the time and effort required for the early planning for the support and use of the computer resources. Full and active participation by experienced personnel in the CRWG is essential for effective computer resource planning. The CRWG chairman

should demand the proper level of support from each of the affected commands.

4.1.5 Request for Proposal

The TS RFP is prepared by the project office. It is prepared for potential contractors, to define system requirements, including source selection requirements for a TS system. For large dollar projects the RFP must be reviewed and approved by a Department of Defense (DOD) committee similar to DSARC before continuing with the TS project. This bid package is vital to the quality of the TS system that is eventually delivered to the Air Force. A high quality well-prepared RFP that clearly expresses the intention of the Air Force is the basis for a high quality TS system. The skills of specialists in all areas of the RFP should be employed. The parts of the RFP covered by this guidebook are:

a. Statement of Work

b. Contract Data Requirements List

c. Information for Proposal Preparation

d. Trainer Simulator System Specifications

4.1.5.1 Statement of Work. The TS SOW is developed in accordance with chapter 7 of AFSCP 800-6, Statement of Work Preparation Guide. The SOW defines the requirements of tasks to be performed by the contractor in the design, development, test and evaluation of the TS system.

The SOW is prepared by the project office in the preparation of an RFP for potential TS contractors. A statement of work may be prepared to cover each phase of a major weapon system contract; i.e., conceptual validation, full-scale development and production. The SOW for a TS system is concerned only with a full-scale development and is the part of the RFP that identifies the full-scale development tasks of design, development, test and evaluation of the TS system based on the system specifications provided as part of the RFP. The intended output is a hardware and software configured system and the documentation needed for inventory use. All tasks that the contractor is expected to perform should be explicitly stated. When data are expected from a task, the task description should be sufficiently detailed to cause generation of the desired information.

The initial SOW is prepared by the TS project office and is included as part of the RFP. The final SOW will normally be the result of the contractor's expansion of the initial SOW as developed during the contract negotiation.

The SOW is written to concide with the Work Breakdown Structure (WBS) which permits a logical arrangement of the elements of the SOW and a tracing of work effort expended under these elements. The WBS is described in MIL-STD-881 and AFSCM 173-4.

TS engineering support is required to provide technical task descriptions for the development of the TS system and for specific documentation required in accomplishment of these tasks. Configuration items should be identified in the SOW if there are more than one. If computer programs are to be developed as CPCIs, the SOW should make that distinction with the appropriate identification of documents required.

It is essential that data rights be obtained for all computer program data that are required for efficient operation and maintenance of the computer programs to be delivered. The SOW should contain a reference to ASPR paragraph 7-104.9(A) that specifies the appropriate data rights provisions.

4.1.5.2 Contract Data Requirements List. The CDRL is the list of data requirements that are required to be submitted to the government by a contractor as a result of a specific contract. The CDRL constitutes the sole list of contractual requirements for the amount and kinds of data required under the contract. AFR 310-1, Management of Contractor Data, describes the CDRL and procedures for specifying data requirements for a contract.

Selection of the CDRL is the responsibility of the project office. The CDRL is a list containing all the data required for delivery to the Air Force in the fulfillment of the contract, and references the appropriate DIDs. Since the TS is often acquired as a single configuration item (CI), rather than a hardware CI and a CPCI, much of the documentation specified by the CDRL will apply to the entire system. Certain documents apply only to software and have DIDs that are specially designed for TS software, these documents are the Computer Program Product Specification and the Training Equipment Computer Program Documentation. The CDRL is of vital importance to the successful acquisition of a TS system and its eventual support. For each TS acquisition, engineering personnel should examine the CDRL to assure all necessary documentation is provided. The CRISP describes all computer resource support requirements and should be used as a checklist for documentation support. Documentation should provide for adequate product baseline identification, means to verify that the delivered software satisfies the TS system specification requirements, maintenance provisions, programming guidelines for the computer program system being used, and configuration management data. CDRL selection and data descriptions are described more fully in Section 5.

4.1.5.3 TS System Specification. The TS System Specification provides the functional, performance and quality assurance requirements for a TS system. TS systems are often acquired as single configuration items, and are not further broken down into a CPCI and a hardware CI. There are conditions when the complexity of a TS system dictates that more than one configuration item be developed. This may also include computer programs as CPCIs. When the requirement for multiple configuration items are established, the system specification will be comprised of the separate specifications for the configuration items.

The TS System Specification is the responsibility of the project office and is written by TS engineering personnel. The system specification is a critical milestone in the acquisition of a TS system. It is the end result of the system engineering process of analyses and trade-off studies conducted by engineering in support of project office. Characteristics of the weapon system to be simulated are not included in the text of this specification, but are referenced to the weapons system characteristics data provided by the weapon system contractor. It forms the allocated baseline from which a contractor will design, test and install a TS system. It is therefore incumbent on the engineers to ensure that the requirements specified are accurate, clearly written and are capable of being verified. The TS system specification is prepared using MIL-D-83468, Military Specification, Digital Computing Systems for Real-Time Training Simulators, which covers the general characteristics and configurations of digital computational systems used in real-time TS and also provides general guidelines for mathematical models. It contains sections covering software requirements and computer hardware requirements. Verification of these requirements are performed at the system level and not at the hardware/software level unless computer programs are designated as CIs. The guidebook for requirements specification provides addi-

tional detail on the TS system specification.

4.1.5.4 Instructions for Proposal Preparation. The IFPP provides the prospective contractors with a detailed description of what is expected in their proposals. As such, this document is of particular importance. It is prepared by the project office as part of the RFP package. It contains the detailed instructions for the preparation of the proposal. It is a key document to obtaining high quality and consistent responses from the bidders. It is written to be consistent with the evaluation criteria specified in the SFE document. In short it pulls the entire bid package together and facilitates the evaluation process. The quality of the bid package is greatly affected by this document.

The Air Force identifies content requirements for the bidders' proposal. It provides information as to the delivery criteria such as submission dates, number of pages in the various parts of the proposal and the general scope of the contract. It may also specify the volumes to be submitted including number of pages, number of figures, paragraph and subparagraph titles and instruction for the contents of each.

Engineering should play a key role in the organization and description of the technical material to be obtained from the bidders. Evaluation of bidders' proposals is simplified by proper attention to organization and content of the proposal volumes. The use of well-qualified and experienced engineers in the preparing the IFPP is essential for obtaining the desired response from the bidders.

4.1.6 Standards for Evaluations

The SFE is prepared by the project office prior to completing the RFP. TS engineering will provide support to the project office by specifying significant technical criteria for evaluating the bidders' proposals. These criteria are used by the proposal review teams to ensure a consistent level of evaluation among the reviewers. The SFE should include a checklist of significant points to be considered with appropriate weighting factors. The SFE is not included in the RFP and is not intended for distribution to the bidders. Rather, the criteria for evaluation should be reflected in the elements that make up the RFP, primarily in the IFPP and the SOW.

4.2 AUTOMATIC TEST EQUIPMENT DOCUMENTS

ATE is normally acquired as part of a major weapon system. One of the significant problems in ATE acquisition is the considerable time lag between the initial planning documentation for the weapon system and the beginning of serious activity for ATE acquisition. Participation in the early planning stages is necessary to assure that proper provisions for ATE software are recognized and planned for during the development of the weapon system.

There is little documentation prepared by the Air Force that is directly applicable to the acquisition of ATE computer programs. The early program requirements and planning documents are directed primarily to the weapon system which the ATE will support. The weapon system ILSP and the CRISP provide an opportunity for some early planning. Normally ATE requirements are not included in a weapon system RFP. ATE is usually acquired by adding to the prime contract via a CCP. However, there are occasions when a separate RFP is issued specifically for ATE. Typically, the weapon system RFP contains a CDRL that requires coordination by ATE engineering personnel. Figure 4.2-1 categorizes the documents prepared by the Air Force into program requirements, program planning

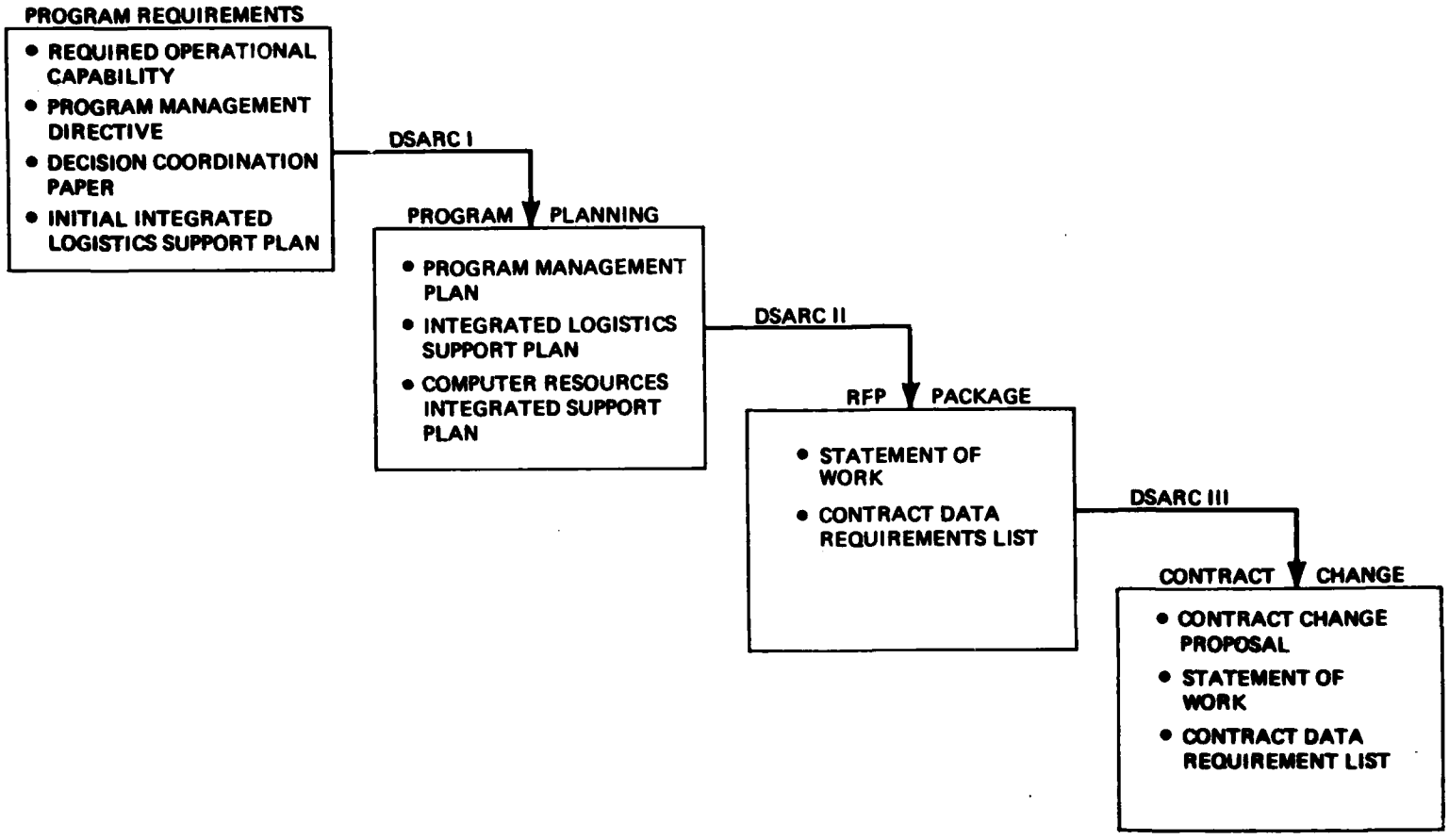

Figure 4.2-1. ATE Government Prepared Documents

and contract packages. In general, documents in these categories are initially prepared in the time periods separated by the respective DSARC.

The most prominent documents prepared for ATE acquisition are the CRISP, the weapon system SOW including the CDRL for the weapon system contract and the CCP for ATE. If ATE is to be acquired under a separate contract, the RFP becomes of vital importance. The following paragraphs describe the preparation of these documents, where they fit in the weapon system life cycle and what responsibilities are fulfilled by the ATE engineering personnel.

4.2.1 Required Operational Capability

The ROC is a formal document used to identify an operational need and to request a new or improved capability for operating forces and is prepared in accordance with AFR 57-1, Required Operational Capabilities. There usually is not a ROC issued specifically for support equipment. In such cases the weapon system ROC will call for support equipment only in very general terms, e.g., support equipment is required to provide a maintenance capability for the weapons system.

The ROC applicable to the acquisition of ATE is usually the weapon system ROC. The generation of operational requirements, consisting of statements of need and the operational capability, is normally an activity of a using command with the collaboration of the AFSC, AFLC and ATC. Preparation of the weapon system ROC is the earliest stage in the acquisition process. Therefore, it is necessarily a relatively high-level document that describes the need for a weapon system and specifies the required characteristics of the system. One of these characteristics is the need for support equipment. At this point it is too early to know if any or how much ATE will be required. In all probability ATE engineering will not be invited to participate in the formulation of the weapon system ROC. The weapon system ROC should be reviewed by ATE engineering to ensure provisions for support equipment are included. The inclusion of appropriate support equipment provisions will forestall future problems when the need to acquire ATE becomes evident. Detailed requirements for ATE probably are not available at the time the ROC is generated, but useful basic guidance can frequently be suggested when problems are foreseen.

In some cases, when a requirement for ATE develops for an operational weapon system, an ATE ROC may be formulated. It is probable that ATE engineering would then be requested to participate in preparing this ROC. An ATE ROC would contain a great deal more detail than the weapon system ROC and would greatly benefit from the experience represented in the ATE engineering support personnel. ATE engineering should be prepared to assist in determining budgetary cost estimates and alternative solutions for satisfying the ROC. Three alternatives are desired, keyed to the concept of minimal, optional and expanded performance:

a. Minimal---Essential Performance Characteristics

b. Optimum Performance Characteristics (or Preferred)

c. Expanded Performance Characteristics (expanded characteristics for enhancement of effectiveness, efficiency and utility).

Whether ATE engineering participates in preparation of the ROC or in reviewing the proposed ROC, emphasis should be focussed on expressing operational requirements rather than describing the technical approach to a solution. It is easy to get "carried away" into a philosophical technical approach rather than

digging out the required characteristics of an ATE system.

4.2.2 Program Management Directive

The PMD is published after validation of the ROC and the ensuing weapons system trade-off studies. The PMD authorizes the development of the weapon system, makes it eligible to compete for funds and directs that plans be prepared for managing computer resources. The major computer resource planning documents are the CRISP and the PMP. Preparation of the PMD is described in AFR 800-2 "Acquisition Management". It should be noted that the PMD is concerned with the weapon system and does not directly address ATE software.

After receipt of the PMD, a study effort is initiated by a Systems Program Office (SPO) cadre to determine various means for satisfying the ROC. A Develop Concept Paper (DCP) is prepared containing a record of basic program information, decision rationale and review thresholds. The DCP and the initial ILSP are prepared for review by DSARC I. When approved the DCP serves as authority to proceed with a particular phase of the acquisition cycle. The SPO cadre then becomes a SPO and work is begun on an RFP.

The PMD and the DCP are published by HQ USAF and the SPO cadre, respectively. Since these documents are weapon system oriented and are far removed in time from ATE activity, there is no ATE engineering participation in their preparation. These documents are usually published in the weapon system conceptual life cycle phase. At that time there have been no specific requirements developed for ATE, only the realization that for the type of systems being developed the use of ATE is highly probable.

4.2.3 Integrated Logistics Support Plan

The ILSP is a document which provides a comprehensive and detailed plan for implementing the concepts, techniques and policies necessary to achieve the integrated logistics support objectives. These are assuring the effective economical support of a logistics elements into program planning, development, test and evaluation, production and operational processes.

The ILSP is prepared by an Integrated Logistics Support Office (ILSO) for and under the guidance of the program manager. It is published initially during the conceptual life cycle phase of a weapon system for which Integrated Logistics Support (ILS) is applicable and specified in the PMD and PMP. Support and test equipment, including ATE, is one of the ILS elements that are considered in the plan. As the system or equipment life cycle progresses, the ILSP continually grows from its initiation in the conceptual phase and evolves with ever-increasing availability of information. The material contained in the ILSP regarding ATE will determine the scope of coverage to be contained in the RFP. The ILS program is described in AFR 800-8, Integrated Logistics Support Program For Systems and Equipment.

ATE engineering support is not provided for the initial release during the early stages of system development. As requirements for ATE are formulated and implemented, the available information should be made available to the ILSO for inclusion in the ILSP.

4.2.4 Request for Proposal.

ATE and its supporting computer programs, are normally acquired by an addi-

tion to the primary weapon system contract. Occasionally ATE may be procured under a separate contract. The preparation of RFP documentation is similar to that described for TS systems in paragraph 4.1.

There is often a time span of up to several years between the time the weapon system RFP is prepared and identification of the required ATE and its computer programs. In spite of the long time span, there are some important items in the weapon system RFP that need the early attention of ATE software engineering. The CDRL and the SOW are of particular importance. The CDRL requires close attention even though specific ATE and, therefore, the supporting computer programs cannot yet be identified. What ATE provisions there are in the SOW are scattered throughout with no formal level of tasking, making it difficult to find and relate all ATE areas. ATE engineering participates in the formulation of the RFP. Even though active participation will be minimal, competent and highly experienced personnel are required. Their experience will determine the effectiveness of the ATE inputs to the RFP. The assumption should be made for modern major weapon systems that ATE software will be required.

The CDRL is of particular importance because it is the contractual means for obtaining data required from the contractor. The CDRL constitutes the sole list of contractual requirements for the amounts and kinds of data required under a given contract. AFR 310-1, Management of Contractor Data, describes the CDRL and procedures for specifying data requirements for a contract.

ATE engineering should provide a recommended CDRL for ATE software (see paragraphs 5.3 and 5.2.2). Since this recommendation is made for the implementing, using and support agencies, it is important that all these agencies are consulted. Often, the ATE software CDRL will be combined with the operational software CDRL resulting in DIDs that contain the same titles, but have no references to ATE software. The approved CDRL and list of DIDs must be reviewed carefully to ensure that adequate provisioning is made for ATE software. The pitfall in not specifying the applicability to ATE, is that the contractor may claim he is not required to provide the desired documentation since it is not specified in the CDRL and the referenced DIDs. The ATE engineer must aggressively pursue the development and progress of the CDRL to ensure references to ATE documentation are not inadvertently removed from the approved list and that ATE provisions are represented in the approved DIDs. If ATE is acquired by contract supplement, the CDRL can be updated or a separate CDRL can be prepared for ATE. The CDRL should be examined carefully to assure that provisions for ATE are adequately covered and any needed corrections or additions are included.

ATE engineering should also review the SOW and the exhibits to ensure that the provisions for ATE that are scattered throughout the RFP are accurate and representative of the weapon system. Since they are scattered, the entire RFP should be examined carefully. Adequate provisioning even at this early date may save negotiating time and contract money if and when a contract supplement is required. It is even more important if ATE software is to be acquired directly through the prime contract. Then it must be clearly stated that ATE is to be provided as part of the support equipment and a more specific definition of ATE requirements must be provided. The contractor must be given the latitude to perform trade-off studies to determine the best mix of ATE and other support equipment that will satisfy RFP requirements.

It is essential that data rights be obtained for all computer program data

that are required for efficient operation and maintenance of the computer programs to be delivered. The SOW should contain a reference to ASPR paragraph 7-104.9(A) that specifies the appropriate date rights provision.

ATE is a high cost item that requires specialized equipment and personnel. Normally there are no provisions for ATE in a WBS for cost collection. Since a SOW is structured around the WBS, ATE provisions are scattered throughout the SOW. Provisions should be made at the WBS level for collection of ATE costs thus allowing ATE provisions to be localized. This would not only simplify the ATE inputs to the SOW and their review but would focus attention on a significant portion of the weapon system that is often overlooked.

4.2.5 Contract Change Proposal

After approval by the government a CCP provides a means for adding support equipment to the weapon systems contract. It will authorize the acquisition of support equipment, including ATE, and will provide the necessary modification to the CDRL and to the SOW to the primary weapons system contract. The CCP should require that a CPDP be prepared which includes the contractor's plan for developing the three types of ATE software, i.e., support software, control software and test software.

The long time span between the weapon system RFP and procurement of ATE and the fact that ATE is a high cost item leads to the need for a contract supplement for ATE. The desired configuration of ATE depends in part on test requirements specified during the development of the UUTs used in the Optimum Repair Level Analysis (ORLA) and the SERD documents. All of the above-mentioned analyses and documents are prepared by the contractor and reviewed and approved by the Air Force. The ATE engineering organization is directly involved with this process and should keep abreast of these analyses, carefully review the resulting documentation and provide comments and recommendations to support final results.

The CCP is normally prepared jointly by the contractor and the Air Force. The CCP will contain a separate SOW that is subject to negotiations between the contractor and the Project Office. ATE engineers provide technical consultation and direction in the preparation of the CCP. This includes agreement on the CDRL, the SOW and the implementation schedule. Items that were not contracted in the prime contract must be negotiated for the CCP. Preparation of the CCP should be closely monitored during its preparation to minimize changes in the review and approval by the SPO.

4.2.6 Program Management Plan

The PMP is concerned with the identification of computer resources and the technical and managerial expertise for managing the acquisition of weapon system software. It is usually written for the weapon system and is based on AFR 800-2, Acquisition Management, supplement 1 and AFP 800-14, Volume II, Acquisition and Support Procedures for Computer Resources In Systems. At the time the PMP is originally released, there is no specific coverage of ATE computer resources. When ATE computer resources are identified, a change to the PMP will be published covering such resources. The PMP provides a requirement for a CRISP to be prepared.

The PMP and the CRISP provide complete planning for acquisition management and technical support of computer resources including ATE for the entire life cycle of the weapon system.

The PMP is prepared by the SPO. Since it is weapon system oriented, there is no ATE engineering participation in its pre-

paration. The PMP is usually published in the weapon system validation life cycle phase.

In the event a PMD and PMP are written specifically for an ATE acquisition, ATE engineering personnel would participate in formulating the PMP. ATE engineering should be prepared to provide the technical expertise for planning the acquisition management of computer resources. The PMP is binding on all participating organizations; therefore, it is important that the ATE PMP receive a meaningful review from all affected organizations, i.e., using, implementing and support commands, before it is published.

Some current programs are attempting to provide an early identification of ATE requirements and required resources. This practice should be encouraged. The earlier planning is begun the easier the eventual acquisition will be.

4.2.7 Computer Resources Integrated Support Plan

The CRISP identifies organizational relationships and responsibilities for the management of technical support of computer resources as specified in AFR 800-14, Volume II, Acquisition and Support Procedures for Computer Resources In Systems. The CRISP functions during the full-scale development phase to identify computer resources necessary to support computer programs after transfer of program management responsibility from the implementing command to the using and support commands. It continues to function after the transfer of program management responsibility as the basic agreement between the supporting and using commands for management and support of computer resources. Again, the initial publication of the weapon system CRISP will probably not give specific coverage to ATE.

The CRISP is written as a part of and in parallel with the PMP. It is prepared by a CRWG consisting of representatives of the implementing, using and support commands. The composition of the CRWG ensures that necessary elements of the CRISP are included in transfer and turnover agreements. The CRISP is a living document in that it is continuously updated during the system life cycle. The CRISP and its updates are the responsibility of the Program Manager. The weapon system CRISP may either be updated to include ATE computer resources after the ATE system is defined or a CRISP may be written that is devoted to ATE computer resources.

During the formulation of the initial weapon system CRISP it is doubtful that ATE engineering would be an active participant. As the system develops and ATE is identified and computer resources are allocated, it becomes increasingly important for representation on the CRWG since the purpose is to provide an integrated support plan that is coordinated and agreed upon by all active participants in the acquisition and support phases.

A separately prepared CRISP for ATE is the preferred approach. It should be prepared after the SERD have been published. The separate CRISP provides for a singular emphasis on the management of ATE resources. When a separate CRISP is prepared, it is mandatory that ATE engineering be represented on the CRWG from its inception.

In either case, whether a separate or combined CRISP is produced, it is sometimes difficult to get the sufficient support from all affected commands for this early planning. The CRWG chairman should demand the appropriate level of support from each command. He should be supplied with experienced personnel that are willing and able to spend the time and effort required for this planning.

Section 5.0 CONTRACT DATA REQUIREMENTS LIST

Selection of a CDRL is of vital importance to the successful management of computer program development activity. Computer programs are a significant portion of TS systems and ATE. CDRL selection differs for TS and ATE computer programs due to the emphasis in the acquisition process. TS systems are usually acquired by separate contract. ATE is usually acquired as part of a weapon system contract and may be delayed up to several years before serious activity begins. The two subjects are treated separately in this section. There are some document commonalities. They will be repeated in each subsection to provide completeness and independence for ATE and TS discussion. General processes and definitions common to both ATE and TS systems are described in the first part of this section.

5.1 SELECTION FACTORS

Selection of a satisfactory CDRL is of vital importance for life cycle considerations of ATE and TS system computer programs. Proper documentation is not only important during the development phase but also in the operation and support phase for these computer programs. Contractor documentation provides the link between the development contractor, the implementing command, the using command and the support command.

Often, lip service is given to the recognition of the importance of computer program documentation; but little time is actually devoted to the analysis and selection of a CDRL. For example, it is easy to say that documentation is important, then scan the authorized data list for DIDs and select all items that appear applicable. The other extreme is to be so cost conscious that important documentation is omitted to the detriment of some participants. Too little documentation may actually increase the total life cycle costs by producing an unreliable computer program product with many errors yet undetected, and by causing the using and support command to either purchase the documentation at a later date or attempt to produce the needed data themselves. Providing needed documentation is cost effective. Producing documentation that is not needed is wasteful. The selection of a CDRL for ATE and TS is usually made by the implementing command for the using and supporting commands. Since documentation is expensive, only those documents that are necessary should be chosen. Each document should have a peculiar purpose. When selecting a CDRL, one must always keep in mind the needs for documentation and choose those documents that satisfy the needs. Computer program documentation should provide for the following:

a. Development planning,
b. Identification of the programs to be developed,
c. Identification of the product to be delivered,
d. Testing,
e. Configuration management,
f. Instructions to the programmer for use of the computer and the languages used, and
g. User and maintenance information.

The CDRL selection process begins with a data call by the project office for all affected agencies. Appropriate DIDs are chosen from the DOD 5000.19-L document to match the requirements listed above. Care must be taken that specific requirements for each ATE or TS application are considered. The list of DIDs is examined. Each DID should be subjected to the following questions:

a. Why is this data item needed?
b. Who will use it?
c. Are any data items on the list redundant?
d. When will they be required?

5.1.1 Identify the Need

The need for each data item should be identified. Does the data item satisfy one or more of the needs listed in paragraph 3.1? If it does not, then it should be eliminated unless there are some other compelling reasons for its use.

5.1.2 Identify the Users

Identification of the users is really an extension of identifying the need. The users may represent more than one command. Since the CDRL is usually chosen by the implementing command for other commands, it is necessary for them to be cognizant of the documentation needed by using and supporting commands. The data items must be examined to ensure that the users needs are satisfied by the data items. If not, other data items should be considered or the data items should be tailored to satisfy the users need.

5.1.3 Redundant Data Items

The DIDs on the proposed list should be examined to determine if there are redundant data items. Redundant items are compared to determine which ones best satisfy the document user's needs. Redundancies should be eliminated. If no one DID satisfies all needs, consideration should be given to tailoring the DID or to writing a unique DID for the project. A DID can be tailored to combine material from several DIDs to achieve a desired result.

5.1.4 Identify the Time Needed

Documentation is of little use if it is not available when needed. Normally, documentation is prepared at specific milestones, meeting specific needs and providing a record of the software development status at that time. These times should be identified, and analyzed to assure that the documentation satisfies the need at a given time. These need dates can then be included in the CDRL.

5.2 DATA ITEM DESCRIPTION

The DID is the description of a data item required to be furnished by a contractor. All approved DIDs are published in DOD 5000.19-L, Acquisiting Management Systems and Data Requirements Control List, also known as the Authorized Data List (ADL). The DIDs in the ADL have been authorized for procurement under the Contract Data Management Program as described in AFR 310-1, Management of Contractor Data.

Most approved DIDs are written for general application. ATE and TS system computer programs have unique requirements which are not covered by the approved DIDs. Therefore, tailoring DIDs for the specific application is necessary. There are enough differences in ATE and TS system computer program documentation to justify the generation of unique DIDs. The process of developing new DIDs is time consuming and will not satisfy current needs because of the amount of calendar time required for authorization (up to two years), but should be considered. Tailoring is the method that can be used for each application and, indeed, should be encouraged. Even if unique DIDs are written and approved, tailoring is still required for each application, though to a lesser degree.

Tailoring is ususally accomplished by using a DID that has been previously modified for a similar application as a baseline, i.e., for a previous ATE or TS acquisition. After the unique features of the new applications are considered the previously modified DID can be tailored by eliminating superfluous requirements and adding others that are missing. The resulting DID will then be tailored to satisfy the exact requirements of the new application.

General tailoring of DIDs has been done to a greater degree for TS computer programs and to a lesser degree for ATE computer programs. The process of developing unique DIDs and tailoring standard DIDs is described in AFR 310-1. Additional information on creating new DIDs, developing unique DIDs and modifying DIDs may be found in ASPR 16-828 and DOD-I-5010-12.

When a unique or tailored DID is prepared, it should be included with the CDRL package. Standard DIDs need only to be referenced because they are readily available to the contractor. The modified DID should be produced on the Authorized Data List, DD Form 1664 "Data Item Description." AFR 310-1 attachment 2 specifies the instructions for preparing the form.

5.3 DATA CALL

The data call is the formal procedure used by a project data management officer to acquire data requirements from participating government activities. ATE and TS engineering are participants. The data call process is illustrated by figure 5.3-1. The initial data call is issued following project approval at DSARC1 when work on a SOW is initiated. Normally this is a weapon system SOW for ATE and the TS system SOW for TS systems. The data call is distributed to the participating government organizations, which include the implementing, using and support commands. Many times the implementing command acts for the using and support commands in this matter.

Each participant analyses his data requirements in accordance with the needs described in paragraph 5.1 then selects an appropriate DID from the authorized data list (DOD 5000.19-L). Often times a DID has been modified for a similar application and can be chosen in place of the basic DID. The selected DIDs are carefully examined to determine their applicability. The selected DIDs are then modified as necessary to satisfy the exact requirements for the application. Form 1664 "Data Item Description" is completed for each modified DID as described in Attachment 2 to AFR 310-1 "Management of Contractor Data." The suffix /M is added to the Data Item Number to designate its modified status. DID forms are always attached to the CDRL when the DID has been modified.

When all data items have been selected and DIDs have been appropriately modified, Form 1423 "Contract Data Requirement List" is completed. Each data item is identified and described according to instructions contained in Attachment 3 to AFR 310-1. In general, the information to be inserted in each block on Form 1423 is adequately described in the instructions. However, blocks 11, 12 and 13 require specific dates. Submittal dates for computer program documentation are better related to certain milestones such as Preliminary Design Review (PDR), Critical Design Review (CDR), Functional Configuration Audit (FCA), Physical Configuration Audit (PCA), etc. For example, a preliminary product specification may be submitted 15 days before CDR. Since there is not enough space in these blocks, block 16 should be used. Care should be taken that the correct distribution of the data items should be thoroughly researched to assure those needing the data are included and that each organization that appears on the list has a need for the number of copies specified.

The completed CDRL is then reviewed by a data requirement review board for all contracts exceeding one million dollars. The project data management offices may approve the CDRL for lesser contracts. The review board may consolidate some items and eliminate others. Some wording may be changed in the review process. Upon approval the initial CDRL is established. The CDRL review process is a continuing activity and is repeated whenever new requirements are established. It is also vitally important

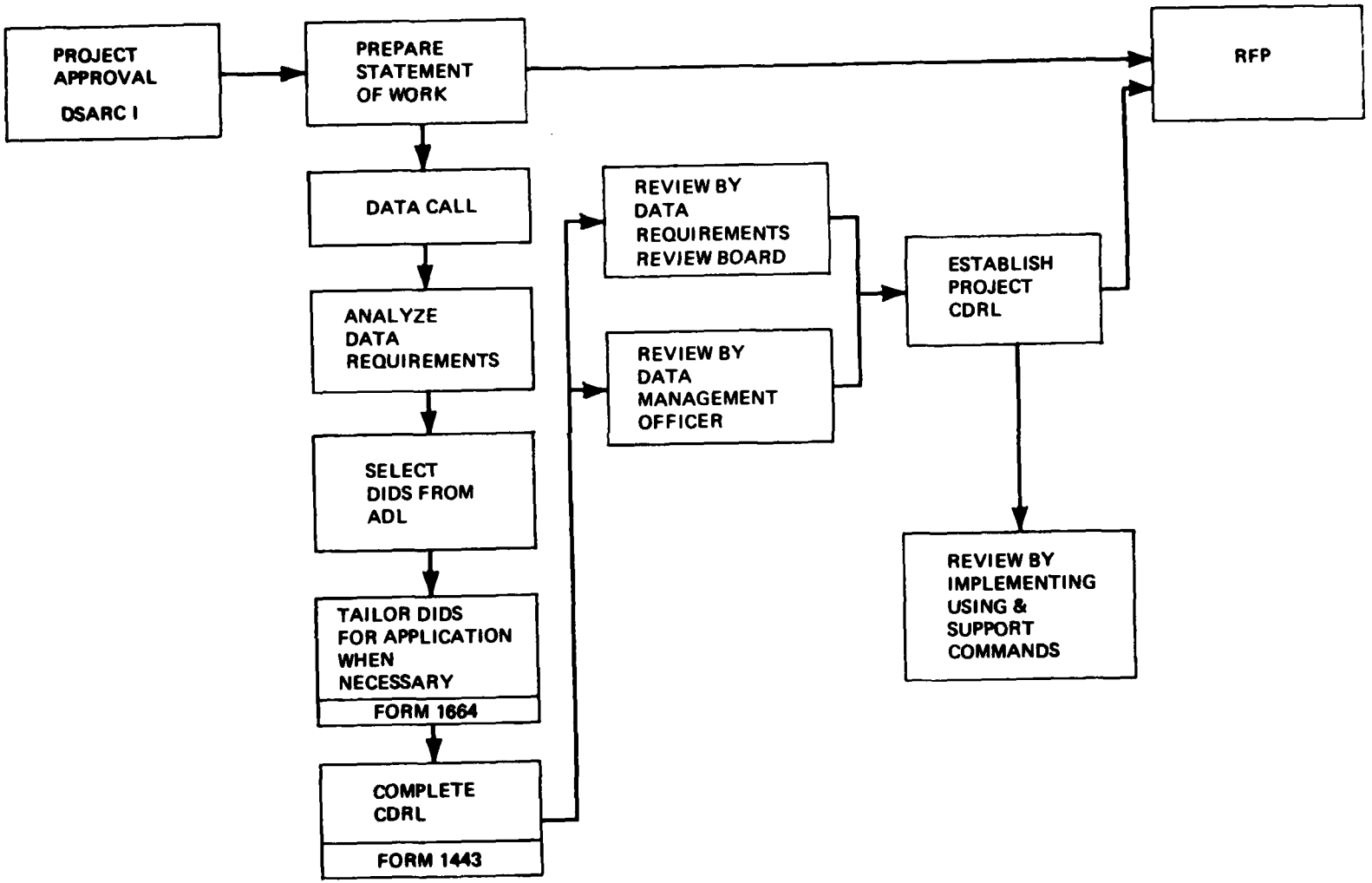

Figure 5.3-1. Data Call Process

that the approved CDRL be reviewed by the organizations that were involved in the CDRL generation to assure that their requirements are still represented in the approval list. The approved CDRL is then included with the completed SOW in the RFP.

TS system acquisitions are usually separate contracts and the data call is both directly applicable and current. It is, therefore, relatively easy for the TS system engineer to keep abreast of CDRL activity. On the other hand, the initial ATE CDRL may be established years before ATE is seriously considered and it is part of a much larger and more expedient procurement. It is important that ATE documentation considerations are not overlooked even at the initial data call. ATE software engineering should respond to the data call and provide their data requirements. Follow-up is necessary after the initial CDRL is published to assure ATE provisions are included; e.g., during the consolidation of similar or identical DIDs, words may be left out making the DID inapplicable for ATE documentation. Since the CDRL for TS systems is usually produced specifically for that application and is also more timely this is usually not a problem. However, nothing should be taken for granted and the final CDRL must be reviewed before the RFP is released.

5.4 DATA ACCESSION LIST

Frequently contractors will prepare documentation for their own use and in their own formats that may be useful to the Air Force but is not included in the CDRL. The use of the Data Accession List technique requires contractors to provide a list of their internal data they are generating for their own use in performance of the contract. The Air Force can acquire this data in the contractor's format, however, it is not subject to Air Force approval or a delivery schedule. These data can thus be acquired at little or no additional cost. The DID describing the data Accession List is DI-A-3027/M-128.

The use of this technique is not intended to replace the careful consideration of a CDRL and placing those requirements on a contractor. Reliance on a Contractor Data Accession List is a dangerous practice and should be avoided. Data requirements should arise from the eventual users of the documents, not the contractor. Contractor documents may be outstanding on ocassion but they have no contractual authority as to content, quality, or the time they are to be delivered. The Data Accession List may not even contain all the documents the contractor has prepared with the Air Force having no way of knowning what documents are readily available. It should be used only as supplementary data that will be useful to the Air Force. When contractor data are found to be useful, their inclusion should be considered for inclusion in future computer program acquisitions.

5.5 DESCRIPTION OF KEY DOCUMENTS

Identification of the key contractor-prepared documents for the acquisition of TS computer programs is based on DODD 5000.29, Management of Computer Resources for Major Defense Systems, which states "Defense system computer resources, including both computer hardware and computer software will be specified and treated as configuration items." Satisfying this requirement implies satisfaction of the needs for documentation specified in paragraph 3.1. This section describes the key documents required for the acquisition of ATE and TS software. The role each of these documents plays is described in its relation to the system acquisition and the computer program acquisition. In essence, the following paragraphs are a recommendation for a CDRL for TS and ATE computer programs. It is based on current Air Force practices and industry experience. Since there is a consider-

able difference between the acquisition processes for ATE and TS software, the discussion will be separated into two separate paragraphs. Paragraph 5.5.1 will cover contractor-prepared documents for TS computer programs and Paragraph 5.5.2 will cover ATE computer programs.

5.5.1 TS Documentation

The following subsections provide descriptions of key documents for TS system computer programs, a summary of the documentation required and a checklist, (Table 5.5-1), for selecting the CDRL for TS computer programs is provided.

TS systems are often acquired as a single CI and specified accordingly. The TS system specification is prepared by the Air Force as described in paragraph 4.1.5.3. It includes both hardware and computer program requirements. If the system is composed of multiple CIs, separate specifications will be prepared by the Air Force. These specifications, prepared by Air Force TS engineering personnel, will be the required development specifications. They will be augmented by the contractor technical proposal.

The TS Computer Program Development Specification consists of the TS System Specification and the contractor proposal and is not specifically identified in the CDRL. All other documentation purposes are satisfied through contractor prepared documents. Some of the documents supporting the computer programs are written at the system level and some are written specifically for computer programs. The following key documents, prepared by the contractor, satisfy the documentation needs specified in paragraph 3.1. The list is based on current acquisition practices an contractor experience.

Computer Program Unique Documents
- Computer Program Development Plan
- Interface Design Description
- Computer Program Product Specification
- Training Equipment Computer Program Documentation
- Version Description Document

TS System Documentation
- Contractor Technical Proposal
- Test Plans and Procedures
- Test Reports
- Configuration Index
- Change Status Report
- Engineering Change Proposal
- Specification Change Notice
- Data Accession List

If computer programs are broken out as CPCIs, separate test plans and test procedures will be prepared for each CPCI. The remainder of the system documents will still be addressed at the system level.

5.5.1.1 Contractor Technical Proposal. The contractor proposal is the bidders response to the RFP. It contains the technical data proposed by the bidders to develop, build and deliver TS systems. Included in the proposal package are a CPDP for the software part of the TS system, and a CMP for the entire TS system.

The technical proposal provides additional contractor-prepared material that is not included in the system specifications. This material is intended to refine the requirements to demonstrate the contractor's understanding of the TS system and to give him a competitive edge. Therefore, it fills out the requirements as the contractor understands them. For this reason the technical proposal will usually become a contract document, albeit, the lowest level of contract requirements; i.e., all other requirements take precedence if there are conflicts.

5.5.1.2 Computer Program Development Plan (UDI-S-3911/ASD). The CPDP is one of the major computer resource planning documents. AFR 800-14, Volume II, Acquisiting and Support Procedures for Computer Resources In Systems, requires a CPDP for the acquisition of computer

Table 5.5-1. Trainer Simulator CDRL Checklist (Sheet 1 of 3)

1. Does the CDRL specify the following documents or their equivalent?

(NO DID)	Interface Design Description
DI-E-3120A/M1	Computer Program Product Specification
DI-H-3277/M3	Training Equipment Computer Program Documentation
DI-E-3121	Version Description Document
DI-T-3703	Category I Test Plans/Procedures (Computer Program)
DI-T-3717	Category I Test Report (Computer Program)
DI-E-3108	Configuration Management Plan
DI-E-3122	Configuration Index
DI-E-3123	Change Status List
DI-E-3134	Specification Change Notice
DI-A-0327	Data Accession List/Internal Data

2. Have DID's been tailored to satisfy all requirements for the specific application?

3. Has each DID been examined to ensure it satisfies the requirements of the specific application?

4. Have appropriate DID's been modified for use of top down structured programming techniques including use of program design language?

5. Have all document users been identified? Have they been consulted?

6. Has time been established for review and delivery for each document? Are schedules related to specific milestone events such as PDR, CDR, etc.

7. Do the DID's for the following documents contain provision for key items as shown below?

Interface Design Description

a. Interfaces specified separately or adequately described in the product specification DID

b. External interface descriptions including

   Data formats
   Frequency
   Methodology for passing and receiving data

Table 5.5-1. Trainer Simulator CDRI Checklist (Sheet 2 of 3)

c. Internal interface descriptions including

   Data base structure
   Methodology for information transfer
   Data types
   Data files
   Size
   Set/used information

Product Specification

a. Complete description of computer program including

   Descriptive narrative
   Logic flows
   Program listings

b. Mathematical model description

c. Computer timing and sizing estimate

d. Top down structured programming techniques

e. Program design language

Test Equipment Computer Program Documentation

a. Program design conventions and philosophy

b. Operating instructions

   Initiating operation
   Maintaining operation
   Restart

c. System generation procedures

d. Programming manuals for each language/computer combination

e. Programmer note book

f. Top down structured programming techniques

g. Program design language philosophy

Table 5.5-1. Trainer Simulator CDRL Checklist (Sheet 3 of 3)

Test Plan/Procedure
h. Test plans for all levels of computer program testing
i. Delivery of "as-run" test procedures
j. Top down integration techniques

programs. It is normally prepared by a contractor for the developing agency as part of the proposal package.

The CPDP applies to all phases of the software development cycle; it is of particular importance to the analysis, design, coding and checkout, and test and integration phases. It defines the contractor's overall plan for developing computer programs and necessary supporting resources. The plan includes identification of the computer program products to be delivered, the development schedule and related documentation. It includes a description of the development organization; responsibilities for design, implementation, testing and integration; hardware and facilities required; and procedures for managing and controlling all aspects of development. The CPDP should be used by the contractor to describe his procedures for controlling design changes prior to the establishment of configuration management baselines. It should address the reporting and management of discrepancies discovered in testing, responsibilities for failure analysis and correction, retesting and the control of both source and object code. In addition, the CPDP should describe the contractor's approach to performance estimation and refinement of the estimates in terms of responsibilities, resource allocation and relationships to the development schedule.

Since the CPDP is prepared as a part of the contractor proposal, it provides an additional factor in the proposal evaluation process. It is also a common practice to place the CPDP "on-contract" thus the contractor is obliged to observe the procedures, controls and methods defined in it. There are some drawbacks to the practice such as being contractually committed to a given organizational structure or to schedules that may prove unrealistic. These drawbacks not only affect the contractor but the Air Force as well, having to negotiate new organizational, structures, schedules, etc.

Since the CPDP is prepared as a part of the contractor proposal, it is not included in the CDRL. However, it is included here as a contractor-prepared document that is required for TS computer program development. The CPDP is called out in the SOW and should be explained in detail in the IFPP. There are several different DIDs describing CPDPs. Four of these are identified below:

a. DI-A-5239
b. DI-S-3591 A/M
c. UDI-S-3911/ASD
d. UDI-E-695/ESD

These DIDs are similar, but all differ somewhat from the content specified in AFR 800-14 Volume II. Each CPDP is designed for a given application and the DID should be specifically tailored to that application. If the CPDP is to be placed on-contract, great care must be taken to tailor the DID in such a way that it satisfies the objective of committing the contractor to a given development process, but does not contain unnecessary constraints. The CPDP must be able to accomodate changes in requirements during the development period. Thus, the contractor should be directed (in the SOW) to update the CPDP at specified, appropriate intervals such as PDRs and CDRs.

5.5.1.3 Interface Design Description (No Applicable DID). Interface design is of more than passing interest in computer program development. In a project with more than one or two programmers involved, exact interface descriptions between programs and between program components become of prime importance in communications between programmers. Interface design is a computer program system engineering task. It is the framework within which the various programs and components exchange information. Data base design is integral to the interface definitions.

Interfaces can be considered at two levels: (1) interface between a computer

program and external devices through I/O channels and (2) interfaces between computer programs and between computer program components. Both are of vital importance. Computer program internal interfaces affect only the computer program designers; external interfaces affect other design organizations.

Experience has shown that interface definitions tend to be overlooked when they are not emphasized in the development process. This lack of definition of the interfaces leads to confusion among programmers and between programmers and other system designers. When given proper emphasis by preparing separate interface documents, a better definition has resulted, it has been easier to review, and interface information has been easier to locate and use for troubleshooting and maintenance. A TS system should combine these into a single interface document for both internal and external interfaces.

The interface design description document includes detailed descriptions of all external interfaces. The exact format, frequency and methodology for passing and receiving data are included. Internal interface descriptions include the data base structure, methodology for passing and receiving data and detailed descriptions of files and of the individual data elements. Included are the data type; e.g., arrays, items, files, etc.; characteristics; e.g., floating point, integer, Binary Coded Decimal (BCD), binary, etc.; identifier; size, e.g., number of bits, bytes, words; identifications of programs that set or use the data items; and a description of the item. The organization of data items into files or other data structures is also shown with the names, dimensions and other distinguishing characteristics of data base files. In some cases, depending on the support software available, much of the information required for these data base files can be produced automatically.

In current TS system acquisitions, these interface data are included as part of the Computer Program Product Specification. There are no DIDs addressing computer programs interface design descriptions. Therefore, a unique DID would have to be generated and submitted to the Command Data Mangement Office for approval by the Command Contractor Data Management Review Board. It must be approved before it can be placed on contract. In the meantime, the corresponding sections in the Computer Program Product Specification can be strengthed by tailoring the existing DID or by locating a DID that primarily addresses interface definition and tailor it for TS computer program interfaces.

The Interface Design Description Document is prepared by the contractor in parallel with the Computer Program Product Specification. A preliminary draft is prepared at the TS computer program PDR and a complete draft at the TS computer program CDR. It is delivered to the Air Force at the PCA.

5.5.1.4 Computer Program Product Specification (DI-E-3120A/M1). The Computer Program Product Specification establishes the detailed technical description of the TS computer programs to be delivered under terms of the contract. It includes a complete description of the TS computer programs including program logic flows and program listings supported by appropriate narrative. A preliminary draft is prepared by the contractor for the PDR, a complete draft is prepared for the CDR and it is delivered at the PCA. When approved it establishes the configuration management product baseline. Changes from this time on require Air Force approval. Prior to delivery, the product specification provides a means for baseline control, internal to the contractor's organization, for design reviews and for information exchange among programmers.

The computer program product specifica-

tion DID for TS systems is DI-E-3120A/M1. This is a version of the basic DID that has been tailored for TS computer programs. In essence, it consists of the first two sections of DI-H-3277 which are the mathematical model documentation and the computer programs system description. Interface design descriptions are addressed but as discussed in paragraph 5.5.1.3, should be either expanded or removed and included in a separate document.

For most computer programs the product specification is a large document. It should, therefore, be divided into a number of volumes to suit the specific application. Separate volumes can be prepared for the overall software system level design, for major TS functions and for the interface definitions. The system level column is prepared as a partial product specification draft to support the PDR and would become a contractor baseline from that time on. The major functions and interface volumes are prepared in draft form for the CDR.

The product specification must be kept current if it is to be of use to either the contractor or the developing agency. The product specification draft provided at CDR should represent a complete design. Computer code is then generated in accordance with the design. Changes are inevitable and are expected. The contractor should describe his approach to handling changes and keeping the product specification draft current in the CPDP. Detailed logic flows and computer timing and sizing estimates in particular remain fluid and require effort to keep current. After delivery to the Air Force it is even more difficult to maintain currency due to the length of time to approve changes through change board action.

There are three parts of a product specification for which a ready correlation should exist: the mathematical model, the logic flows and the program listings. Care should be taken to assure that these three parts can be easily correlated by clearly annotating these parts. Program listings represent the actual executable computer program code, the logic flows represent the design and the mathematical models represent the theory behind the design. The use of top-down structured programming techniques may include the use of a program design language (PDL). The logic flows may be expressed in the PDL and are used in place of the traditional flow charts. The product specification DID should be tailored to provide for this possibility.

5.5.1.5 Training Equipment Computer Program Documentation (DI-H-3277/M3). Training Equipment Computer Program documentation is a composite of three documents: (1) a user's guide, (2) a programmer's notebook, and (3) a computer programming manual. Training Equipment Computer Program Documentation is prepared by the contractor and delivered to the Air Force at the PCA. The controlling DID is DI-H-3277/M3. This is a tailored version of the basic DID. It is to be used in conjunction with the product specification described in paragraph 5.5.1.4. The first two sections of the basic DID, Mathematical Model Documentation and Computer Program systems Description, are removed from this document and included in the product specification and a section, Computer Vendor Programming Manuals, is added. The purpose of training equipment documentation is to augment the product specification and to provide all technical data required for TS computer program maintenance and operation. The documentation may be included in a single volume or may be divided into three volumes depending on the size and expected use of the section. The three sections are described in the following paragraphs.

a. Computer Program Users Guide - The users guide section provides a description of how the computer programs were designed. It describes the general

approach, methods employed and standards used to produce the product specification and the computer program. In short, it covers most of the areas needed for computer program maintenance. However, user information regarding usage instructions (how to use each specific function), computer operating instructions and system generation instructions as described in DI-M-3410 are not included in DI-H-3277/M. The DID should be modified to include these items. The first two items are necessary for: initiating the computer program operation, maintaining its operation, and terminating and restarting program operation. System generation procedures are necessary for program maintenance when changes have been introduced and a new computer program system must be generated. These procedures also provide a means for quality assurance inspection of the system generation process. If top-down structured program (TDSP) techniques are used, the TDSP philosophy should be provided. If a PDL is used in place of the traditional flow charts, the PDL philosophy should be included to enable program maintenance personnel to understand the specific techniques used.

b. Computer Programmer Notebook. This section is an informal collection of the programmer notes to explain nonstandard approaches to certain design or coding problems. It also provides a record of the problems encountered during coding and debug. This section can be of significant value for program maintenance as it explains some of the apparent alterations in coding techniques.

c. Computer Vendor Programming Manuals. The purpose of this section is to provide programming instructions for a specific computer and a specific programming language. A section is required for each language and/or computer used. It is approximately the equivalent of DI-M-3411 with the exception that it does not have provisions for a situation in which only limited or no manuals are available from the computer vendor. The DID should be modified to include this provision. Availability of computer program documentation should be a part of the computer vendor selection process. If the required manauls are not available, information is still required and should be provided by the contractor in accordance with the aforementioned DID. Consideration should be given to replacing Training Equipment Computer Program Documentation by a Users Guide DI-M-3410 and a Computer Programming Manual DI-M-3411. These DIDs already contain the missing parts as described above. These DIDs should be tailored to include the desirable parts of DI-H-3277/M3. This would make the CDRL more like other computer program acquisitions and therefore, simplify a transition from other software acquisitions to TS computer programs.

5.5.1.6 Version Description Document (DI-E-3121). The purpose of the VDD is to identify the exact configuration of TS computer programs and the interim changes thereto. It is used to identify each version, and accordingly, accompanies each version of the TS computer program and each release of an interim change. The VDD is prepared by the TS contractor in accordance with DI-E-3121. The DID essentially refers to MIL-STD-483 for contents description. The VDD is delivered to the Air Force at PCA and is an exact description of the TS software configuration delivered at that time.

Many different versions of computer programs are generated and used during the installation and operational phases. Several of these versions may in use simultaneously. Configuration management of the evolution of computer programs can be a monumental problem if there is no means for identifying the separate versions. Basically, a new version is created whenever any change is made. The VDD provides the same function as a top level hardware drawing in that it identifies the exact version of each component that makes up the computer program. The

exact design and code changes to a specific version of a program component are described in the product specification complete with logic flow and program listings; however, a composite program configuration consisting of a specific version of program components is very difficult if not impossible to identify the exact configuration all the software tools required to generate the deliverable computer programs. This includes the version identification of compilers, assemblers, link editors and all other software tools used in the process.

5.5.1.7 Test Plans and Procedures (DI-T-3703). Validation of TS computer programs is usually performed as part of the TS system validation. Therefore, separate test plans and procedures are not prepared for computer program validation unless computer programs are developed as CPCIs. Test plans and procedures are prepared by the TS system contractor as specified by DI-T-3703.

Test plans are prepared in accordance with Section 4 of the TS system specification. The initial draft of the plan should be available for review at the PDR, the final version at CDR. Test plans should show the entire test plan leading to acceptance of the TS system. This includes programmer level tests, computer program integration tests, tests of the computer programs independent from the TS software and TS system level tests.

Test procedures are prepared for each individual qualification test and specify the test process including identification of the equipment configuration, equipment set up, computer program configurations, step-by-step procedures and expected results. The contractor may provide internal test procedures for lower level tests leading to qualification. These procedures are not required to be delivered by contract, but may be obtained using the data accession list techniques (paragraph 5.4).

Test plans may be prepared as a separate volume since they are prepared in advance of test procedures. In fact, each separate test procedure could be prepared as separate volumes depending on the size of the tests. Test procedures for formal qualification and acceptance tests must be approved by the Air Force prior to testing. Changes made during a test must be recorded in the test procedure that is delivered at FCA. This will describe the test procedure actually performed.

5.5.1.8 Test Reports (DI-T-3717). Test reports are required for describing the results obtained from the qualification test procedures described in paragraph 5.5.1.7. They are prepared by the contractor in accordance with DI-T-3717. They should be delivered within a specified time period following the test completion. The delivery should be specified in block 12 of the CDRL Form 1423. The results are used as part of the FCA process. Delivery of lower level test reports may be obtained from the contractor using the data accession list technique (paragraph 5.4).

5.5.1.9 Configuration Management Plan (DI-E-3108). The CMP is prepared by the contractor to describe his assignment of organizational responsibility and the procedures used in the accomplishment of the specific configuration management requirement as stated in the SOW. The CMP is prepared as part of the contractor proposal and often becomes contractual after contract award and approval by the Air Force. Even though the CMP is prepared for the TS system, it should contain provisions for configuration management of computer programs. Procedures unique to computer programs should be described in the CPDP and referenced by the CMP. The CMP is prepared in accordance with DI-E-3108 and MIL-STD-483.

5.5.1.10 Configuration Index (DI-E-3122). The configuration index for a computer program is part of the integrated approach to configuration manage-

ment in accordance with Appendix VIII of MIL-STD-483, Configuration Management Practices for System, Equipment, Munitions and Computer Programs. It provides a record of the current status of specifications and selected additional documents, such as: test plans, procedures and reports, users manuals and VDDs, which depend for item content on the TS system configuration. Document status is summarized by dates of issue, document numbers and titles, ECPs, SCN, and revision identifier associated with each issue. Additionally, it contains a summary record of milestones pertaining to the TS development, audit and qualification. It is prepared by the contractor as soon as the documents it contains are released.

5.5.1.11 Change Status List (DI-E-3123). The Change Status List is supplementary to the configuration index. It details the status of all proposed changes to the trainer simulation system for which the contractor is responsible and for which existing documentation is listed in the Configuration Index. It contains a list of each successive ECP, by number, prepared against the TS system, with a brief indication of the status of the ECP; and a detached summary of the status information for each ECP which is currently active. It is prepared by the contractor in accordance with DI-E-3123 and MIL-STD-483. It is a continuing record of the status of proposed and approved changes.

5.5.1.12 Engineering Change Proposals (DI-E-3128). The ECP is the vehicle used to prepare, process and incorporate Class I engineering changes to the applicable configuration management baseline, i.e., development specification or product specification. It is usually prepared by the contractor and must be approved by the government. It is prepared when a change is considered appropriate and in accordance with DI-E-3128.

5.5.1.13 Specification Change Notice (DI-E-3134). The SCN identifies a proposed change to a contractually applicable specification and, after approval, provides a record of the change and the associated ECP. The SCN is prepared by the TS system contractor whenever an engineering change is proposed, and is included as part of the ECP package. The SCN is prepared in accordance with DI-E-3134 and MIL-STD-483.

5.5.1.14 Data Accession List/Internal Data (DI-A-0327). The data accession list is an index of contractor data which is available upon request. It identifies all contractor internal data which have been generated by the contractor in compliance with the work described in the SOW. The Data Accession List is prepared in accordance with DI-A-0327.

5.5.1.15 TS Documentation Summary. Key TS computer program documents have been described in the preceding paragraphs. Each of these documents is prepared for a specific purpose and none are redundant. The preceding paragraphs cover the documents that are prepared by the contractor and affect computer programs. Included are documents prepared specifically for computer programs and those prepared for the entire TS system. In some cases, when computer programs are treated as configuration items, documents such as test plans, test procedures and test reports will be prepared specifically for computer programs.

One question that frequently arises is the format in which the documents are prepared. The formats of the aforementioned documents are specified in the controlling DIDs with the exception of the Computer Program Product Specification and the Training Equipment Computer Program Documentation. Frequently the contractor will suggest that this inter-

nal documentation nearly satisfies the required DIDs but is in a different format.

The contractor may propose changes to the DIDs as part of his proposal. These changes should be evaluated as to whether they satisfy the document requirements. Cost alone should not be the deciding factor, but rather whether the required data is present and in a form that is convenient to use. Contractor formats are different and therefore may be difficult to evaluate. Standard formats are different and therefore may be difficult to evaluate. Standard formats are preferable, but contractor formats should be accepted when conditions of contractor formats and data content warrant this. Good ideas and better methods of presenting data should be used to update the present set of DIDs and in the long run to minimize contractor unique formats.

Another question is the effect of TDSP techniques on computer program documentation. Use of TDSP may affect the product specification, test plans and procedures, the CPDP and the training equipment computer program documentation. These DIDs have no provisions for TDSP techniques and must be updated. Program logic flows may be expressed in a PDL rather than flow charts. Top down integration of computer programs would affect test plans and configuration management techniques. The effects are still controversial but appear to be beneficial as more visibility is generally provided. DIDs should be tailored to take advantage of these techniques.

5.5.1.16 TS CDRL CheckList. Table 5.5-1 is a checklist for the selection of a CDRL for TS computer program documentation.

5.5.2 ATE Documentation

The following subsections provide descriptions of key documents for ATE computer programs, a summary of the required documentation and a checklist, Table 5.5-2, for selecting the CDRL for ATE computer programs. The Support Equipment Plan (SEP) and SERD are early documents in leading to the ATE contract supplement. While they are not directly applicable to computer program documentation they are included here as vital documents for the weapon system CDRL. Identification of key contractor-prepared documents for the acquisition of ATE computer programs is based on DODD 5000.29, Management of Computer Resources for Major Defense Systems, "Defense systems computer resources, including both computer hardware and computer software will be specified and treated as configuration items." Satisfying this requirement implies satisfaction of the need for documentation specified in paragraph 3.1. These needs are satisfied through the contractor-prepared documents listed below. This list is based on current acquisition practices and contractor experience.

Support Equipment Plan
Support Equipment Recommendation Data
Computer Program Development Plan
Computer Program Development Specification
Test Requirements Document
Interface Design Description
Computer Program Product Specification
Test Plans/Procedures
Test Reports
Computer Programming Manual
User's Manual
Computer Software Maintenance Manual
Version Description Document
Configuration Management Index
Configuration Index
Change Status Report
Engineering Change Proposal
Specifiation Change Notice
Data Accession List

ATE computer programs are usually separated into three categories. These are: test software, control software and support software. A fourth category,

Table 5.5-2. Automatic Test Equipment CDRL Checklist (Sheet 1 of 4)

1. Does the weapon system CDRL specify the following documents or their equivalent?

DI-A-6102	Support Equipment Plan
DI-S-6176	Support Equipment Recommendation Data
DI-T-3734	Test Requirements Document
DI-E-3108	Configuration Management Plan
DI-E-3122	Configuration Index
DI-E-3123	Change Status List
DI-E-3128	Engineering Change Proposal
DI-E-3134	Specification Change Notice
DI-E-3027	Data Accession List/Internal Data

2. Does the weapon system CDRL or CCP CDRL specify the following ATE computer program related documents for each CPCI?

UDI-S-3911/ASD	Computer Program Development Plan
DI-E-3119A	Computer Program Development Specification Interface Design Description
DI-E-3120	Computer Program Product Specification
DI-T-3703	Category I Test Plans/Procedures (Computer Programs)
DI-T-3717	Category I Test Report (Computer Programs)
DI-M-3411	Computer Programming Manual
DI-M-3410	Computer Program User's Manual
DI-E-3121	Version Description Document

3. Have DID's been tailored to satisfy all requirements for the specific application?

4. Has each DID been examined to ensure it satisfies the requirements of the specific application?

5. Have appropriate DID's been modified for use of top down structured programming techniques, including use of a program design language?

Table 5.5-2. Automatic Test Equipment CDRL Checklist (Sheet 2 of 4)

6. Have all document users been identified? Have they been consulted?

7. Are all documentation requirements known?

8. Has time been established for review and delivery for each document? Are schedules related to specific milestone events such as PDR, CDR, etc?

9. Do the DID's for the following documents contain provisions for key items as shown below?

Computer Program Development Plan

a. Contractor error detection, correction and control procedures

b. Plan for developing computer programs and supporting resources

c. Identification of products to be delivered

d. Description of computer program development organization

e. Control of design changes

f. Configuration management techniques during computer program development

Computer Program Development Specification

a. Explicit definition of what the program shall do

b. Performance parameters to define how well it shall perform

c. Validation requirements

d. Interfaces with vendor supplied programs for changes to control and support software

e. Each requirement singularly expressed and identified

f. References to TRD for test software

g. ATLAS statement preparation requirements for test software

h. Test software interfaces with support and control software CPCI's

Table 5.5-2. Automatic Test Equipment CDRL Checklist (Sheet 3 of 4)

Test Requirements Document

a. Tailored for compatibility with the test software development specification

b. Designation of parts to be written in ATLAS if any

Interface Design Description

a. Interfaces specified separately or adequately described in the product specification DID

b. External interface descriptions including:

   Data Formats
   Methodology for passing and receiving data
   Frequency

c. Internal interface descriptions including:

   Data base structure
   Methodology for information transfer
   Data types
   Data files
   Size
   Set/used information

Product Specification

a. Complete description of computer programs including:

   Descriptive narrative
   Logic flows
   Program listings

b. Computer timing and sizing estimates

c. Top down structured programming techniques where applicable

d. ATLAS statements where applicable

Test Plans/Procedures

a. Plans for all levels of computer program testing

b. Delivery of as-run test procedures

c. Top down integration techniques where applicable

Table 5.5-2. Automatic Test Equipment CDRL Checklist (Sheet 4 of 4)

Computer Programming Manual

a. Separate manuals for each language/computer combination

User Manual

a. Program design conventions and philosophy

b. Operating instructions

   Initiating operation
   Maintaining operation
   Terminating operation
   Restart

c. System generation procedures

d. Top down structured programming techniques if applicable

e. Program design language description if applicable

self-test software is sometimes considered separately, but is included in the test software category for the purposes of this guidebook. Each category may be handled separately with each type identified as a CPCI. Each type has its own characteristics; where applicable, each type will be described separately.

5.5.2.1 Support Equipment Plan (DI-A-6102). The SEP is a contractor prepared document resulting from an ORLA. The ORLA is an iterative decision process conducted by the contractor throughout the validation, development and production phases of a weapon system life cycle. The analysis considers all maintenance factors and determines the optimum level of repair for all weapon system configuration items, i.e., organizational, intermediate or depot. It identifies the repair locations, the extent of maintenance permitted and the resources necessary to support the repair process. The ORLA will provide the justification of any contractor recommendation for support resources.

The SEP is prepared using data resulting from an ORLA. The plan describes how the contractor will develop the support equipment resources. Upon approval of the SEP by the Air Force the contractor begins preparation of the SERD. The SEP is prepared in accordance with DI-A-6102. Figure 3.3-1 shows the SEP in relation to the TRD and SERD. It is prepared during the full scale development phase prior to approval or in support of a contract change for ATE. The document is not prepared specifically for computer programs, but the ATE engineer should ensure that it is specified in the weapon system's CDRL.

5.5.2.2 Support Equipment Recommendation Data (DI-S-6176).

The SERD provides the contractors' recommendation for specific support equipment to be used for weapon system maintenance. It will identify the contractor's choice for ATE including the computing equipment systems required. Air Force concurrence with the SERD is required prior to authorization for the contractor to proceed with further development or procurement of ATE. The SERD will identify ATE hardware and software and other types of support equipment. The SERD is prepared in accordance with DI-S-6176. It is prepared during the full scale development phase as shown in Figure 3.3-1. The SERD is the result of extensive analyses conducted by the contractor with close Air Force monitoring and involvement. The SERD is a vital part of the ATE requirements definition and must be included in the weapon system CDRL.

5.5.2.3 Computer Program Development Plan (UDI-S-3911/ASD). The CPDP is one of the major computer resource planning documents. AFR 800-14 Volume II requires a CPDP for the acquisition of computer programs. It is normally prepared by a weapon system contractor for the implementing agency after a contract change for ATE has been negotiated. If ATE is acquired under a separate contract the CPDP is prepared as part of the contractor proposal. The CPDP applies to all phases of the computer program development cycle.

It defines the contractor's overall plan for developing computer programs and necessary supporting resources. The plan includes identification of the program products to be delivered, the schedule for each and related documentation. It includes a description of the development organization; responsibilities for design, implementation, testing and integration; required hardware and facilities and procedures for managing and controlling all aspects of development. The CPDP should cover all three types of ATE software and show the CPCI identifications. The development may be significantly of ATE software and show the CPCI identifications. The development may be significantly different for each type. For example, all support software may be provided by a computer vendor; control

software may be obtained from the computer vendor but require additions or modifications to be made either by the vendor or by the contractor's software organizations; test software may be coded and validation by a test or design organization. In any case, the entire process, the organizational tasks and responsibilities are specified.

The CPDP should be used by the contractor to describe his procedures for controlling design changes prior to establishment of configuration management baselines. During module and integration testing, the CPDP should address the reporting and management of discrepancies discovered in testing, responsibilities for failure analysis and correction, retesting and the control of both source and object code. In addition, the CPDP should describe the contractor's approach to performance estimation and refinement of the estimates in terms of responsibilities, resources allocation and relationships to the development schedule.

Since the normal method for acquiring ATE is by augmenting to a weapon systems contract by a contract change, the CPDP is included in the CDRL as a separate document devoted to ATE computer programs. It is commonly placed on-contract, requiring the contractor to observe the procedures, control and method defined therein. There are some disadvantages to this practice such as being contractually committed to a given organizational structure or to schedules which may prove unrealistic. These disadvantages not only affect the contractor but the Air Force as well, requiring negotiating of any changes that may occur.

There are several different DIDs describing CPDPs, four of which are identified below:

a. DI-A-5239
b. DI-S-3591A/M
c. UDI-S-3911/ASD
d. UDI-E-695/ESD

These DIDs are similar, but all differ in some aspect from the content specified in AFR 800-14 Volume II. Each CPDP must be designed to fit a specific application; the corresponding DID must be specifically tailored to that application. If the CPDP is to be placed on-contract, great care must be taken to tailor the DID in such a way that it satisfies the objectives of committing the contractor to a specified development approach, but does not contain unnecessary constraints. The CPDP must be able to accommodate changes in requirements during the development period. Thus, the contractor should be directed (in the SOW) to update the CPDP at specified, appropriate intervals such as the preliminary design review and critical design review.

5.5.2.4 Computer Program Development Specification (DI-E-3119A). The purpose of a Computer Program Development Specification is to provide the functional, performance and quality assurance requirements for a CPCI. It is prepared by the ATE contractor during the analysis phase of the ATE computer program development cycle, and is one of the most significant products of that phase. It should be completed and approved by the CPCI PDR. Upon approval by the Air Force, the development specification is placed under Class I control and becomes the allocated baseline. All computer programs are required by AFR 800-14 to be developed as configuration items; thus a development specification is required for each ATE CPCI.

The purpose of a development specification needs to be reviewed at this point. A development specification is prepared primarily as a two-way agreement between the Air Force and the development contractor. It is prepared independent of the design approach. It specifies what the software shall do (function), how

well it shall do it (performance) and under what conditions (design constraints). In addition, it provides validation requirements that define the scope of the validation program. The specification is used as the functional and performance baseline for the contractor in developing computer programs and is also used as the baseline on which Air Force acceptance or rejection of the computer program is based.

A statement of computer program requirements, that have been approved by the Contractor and the Air Force, is a necessary instrument for a clear understanding of what the contractor will produce and what the Air Force expects. The three basic categories of ATE computer programs present different problems in the need and generation of development specifications. The form and substance of a development specification may vary for each CPCI depending on the category and the degree to which it must be developed. Since ATE software categories are different, they are often designated as separate CPCIs. That implies separate specifications, separate development schedules, separate review schedules and separate validation of requirements that must all be coordinated and eventually "sold" as a unit. This raise the possibility of an ATE Software System Specification covering all CPCIs, as well as the individual CPCI specifications. Since the CPCIs can and do have separate development schedules, each CPCI would have its own PDR and CDR schedule; e.g., normally the control and support software development precedes that of the test software.

5.5.2.4.1 Control and Support Software. Most of the time, control software and support software are purchased from an ATE vendor as part of a test set or separately from the computer manufacture. Control software and support software are usually identified as separate CPCIs. When these computer programs are purchased "off-the-shelf", development specifications are not required. Computer vendor documentation is required for computer program maintenance and for the possibility of making changes to the purchased computer programs. The equivalent of a product specification (paragraph 5.5.2.7) should be obtained from the vendor if at all possible. Program listings and source code are almost indispensable. When significant additions or changes must be made to the purchased control or support software, a development specification should be written covering the changes to be made, and the interfaces required with the purchased computer programs and the test equipment. The existing computer program (obtained from the vendor) is identified as an interface and the additional software, treated as a CPCI, will be designed, tested, reviewed and controlled accordingly. When control and support software are to be totally developed by the contractor, a complete development specification is required.

5.5.2.4.2 Test Software. There is considerable controversy within the Air Force and contractors as to whether a development specification is applicable for test software. One point of view is that test software is a computer program and must be developed as a CPCI; therefore, a development specification is required for proper control of the development process. The other point of view is that test software is derived from a TRD (paragraph 5.5.2.5) which can be most efficiently written directly in the Automatic Test Language For All Systems (ATLAS) language by a UUT design engineer, thereby, bypassing the need for a development specification or at least regarding the TRD as the development specification.

Figure 5.5-1 illustrates the engineering process performed in the development of requirements for test software. The important point is the dependency of test software on test procedures specified in the TRD, ATE test set and the interface test adapter (ITA). The TRD is prepared for a production UUT and is

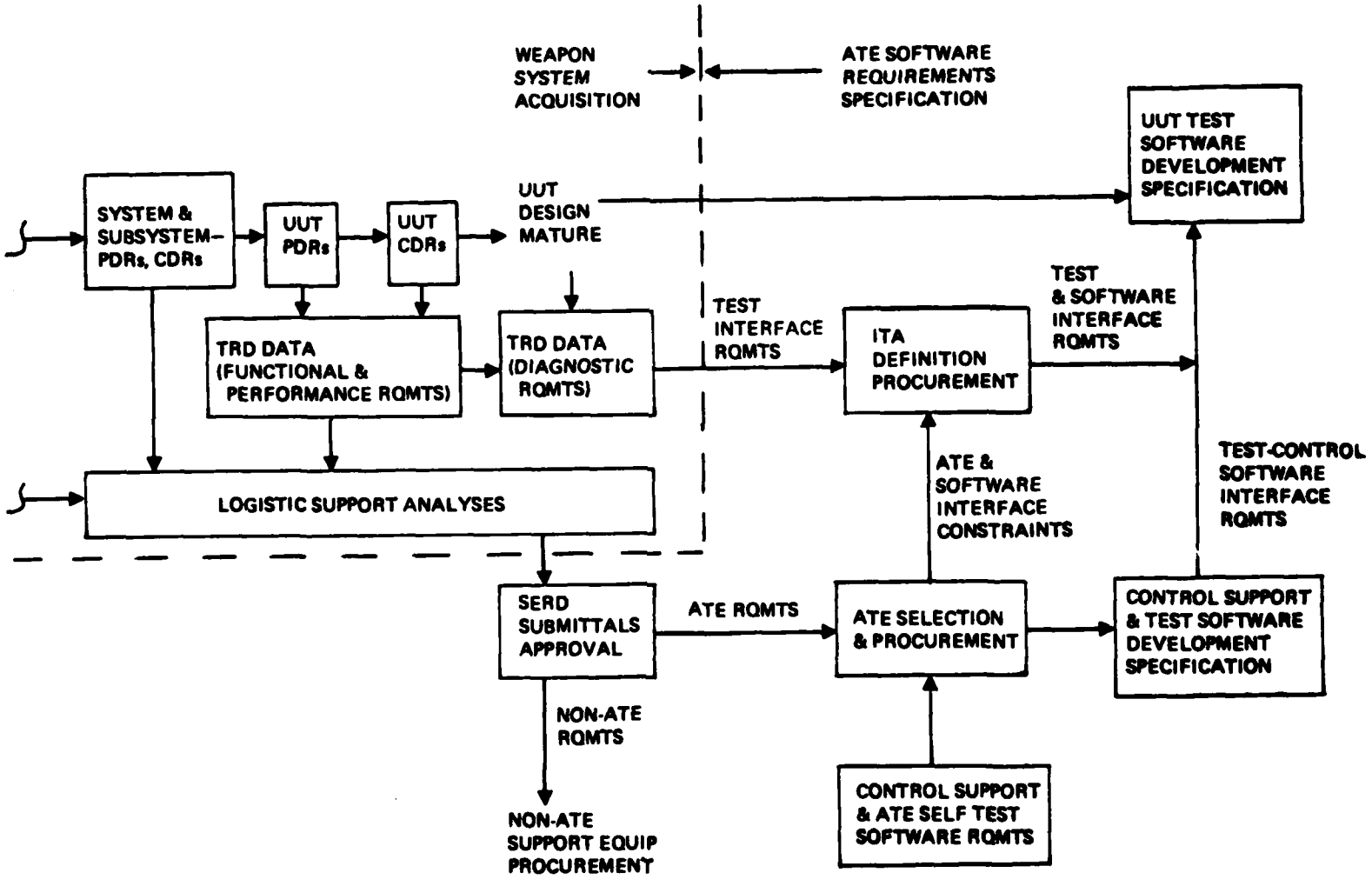

Figure 5.5-1. Key Events in ATE Software Specification

independent of the test set (including support and control software) and the ITA. That is unless the test procedure portion of the TRD is written in the ATLAS language and the ATLAS statements processed directly by the ATLAS processor. It is obvious that the TRD itself is not an adequate substitute for a development specification and cannot provide the design definition and control required for a CPCI.

Since there is no consensus on this point, the author presents the following proposal which appears to address both sides of the controversy. First, a development specification is required to provide the basis for design, management control reviews, verification, and configuration management requirements. Second, a provision is made for writing the automatic test procedures in the ATLAS language as part of the TRD.

Figure 5.5-2 illustrates the source and interactions of the ATE data that become a part of the specification. The interface section of the specification describes the interfaces or design constraints imposed by the control and support software, CPCIs, the test equipment and the ITA. These constitute the primary interfaces. They obviously cannot be written until these contributing elements are defined as shown in Figure 5.5-1.

The functional and performance requirements are mostly made up of TRD data produced by the UUT designers. The automatic test procedures defined by the TRDs are referenced by the specification and are written in the ATLAS language in accordance with requirements specified in the Design Requirements section of the development specification (or Special Requirements sections in the MIL-STD-483 format). The referenced procedures become part of the specification. The remainder of the functional and performance section consists of requirements that are applicable to the framework by which the indivdual automatic test procedures are combined to produce an integral test software CPCI.

The Design Requirements section consists of the functional/performance requirements that affect the design of the test programs. One such requirement would be the specific ATLAS version to be used. Since the TRDs contain may indivdual test procedures related only to the UUT, this section provides specific requirements for the applicable portion of the TRD in ATLAS. The purpose of this requirement is to assure that the ATLAS code produced from the TRD is compatible with the remainder of the ATE computer program systems.

The Quality Assurance section consists of the requirements to verify that the delivered computer programs perform in accordance with the requirements in the preceding sections.

The description of the development specification implies a schedule sequence similar to that shown in Figure 5.5-3. The figure shows the definition of the ATE equipment, the ITAs and the control and support software all precede the development specification. The Test software CPCI PDR is conducted following completion of the development specification. The TRDs can be written (in ATLAS) anytime after the design requirements are established.

There are no DIDs designed specifically for the different categories of ATE software. DI-E-3119A is the controlling DID for Computer Program Development Specifications. There is a need for DIDs that specifically address these types of software. It is therefore necessary to tailor the current controlling DID for the specific type; e.g., the test software DID could be tailored to fit the development specification described above.

5.5.2.5 Test Requirements Document (DI-T-3734). The TRD defines the testing required to validate the unit to be

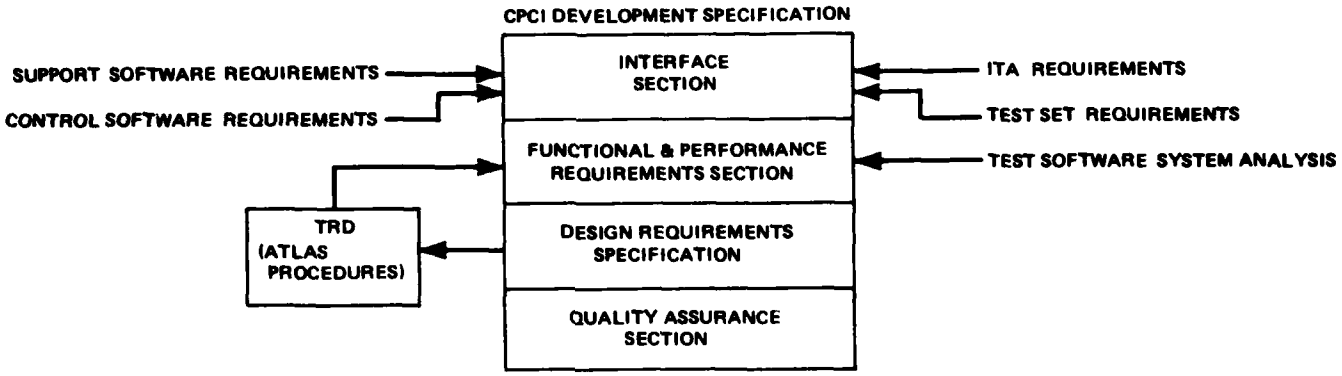

Figure 5.5-2. Test Software Development Specification

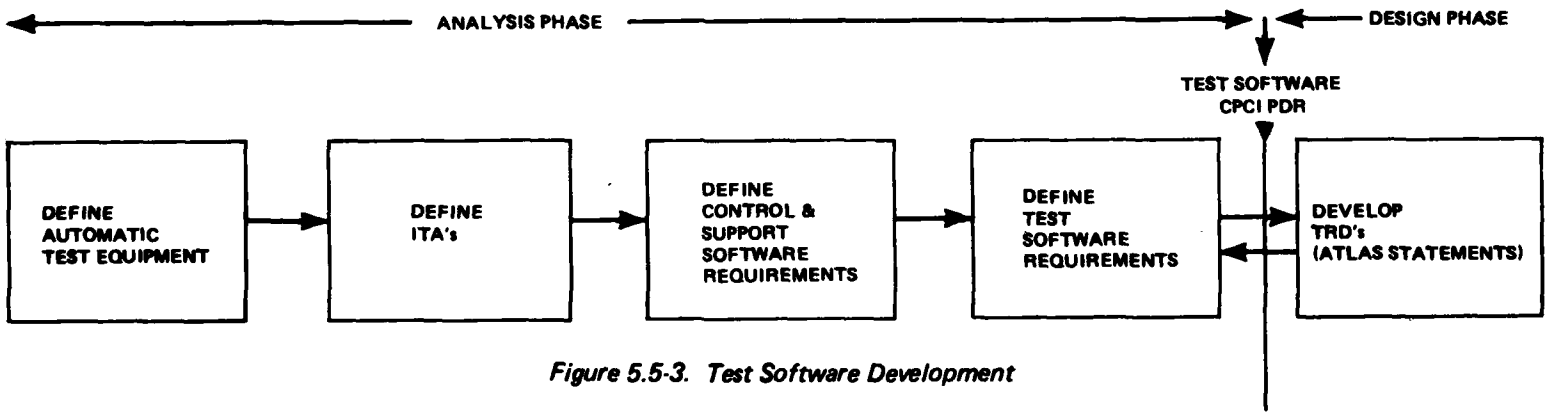

Figure 5.5-3. Test Software Development

tested. It is usually prepared by a contractor logistics engineer and submitted to AFLC for approval. The UUT designer generates the required test procedures that are included in the TRD. These test procedures are prepared in advance of the TRD and are the basis for the test software. The design may be from the prime contractor's design organization or may be a subcontractor. If the TRD is to be prepared by a subcontractor, the prime contractor should provide explicit instructions for its preparation to ensure that it conforms to the requirements specified in the Computer Program Development Specification.

As shown in Figure 5.5-1, some TRD data (based on the UUT design) is available prior to the ATE procurement. These data support the analyses that are performed to define the support equipment and thus the ATE. The test procedures to be included in the TRD are finalized after the factory acceptance test procedures for the UUT. The test procedure to be used for automatic testing may be written directly in ATLAS if the requirements for preparation in ATLAS have been previously specified in the development specification. If the automatic test procedure portion is not written in ATLAS, it must be converted at a later time. Direct preparation of the TRD in ATLAS is controversial; some advocate it, believing it to be more efficient; others feel that not enough control is obtained. Writing the test procedure directly in ATLAS can be done efficiently if appropriate planning and preparation is done before hand.

The existing DID, DI-T-3734, does not describe adequately a TRD to be used for ATE in the context described in this and the preceding paragraph. The DID references MIL-STD-1519 which was written before ATE was in wide use. The TRD is now used in a wider context than originally intended. It is therefore necessary to tailor the DID such that the information can be used to support the Computer Program Development Specification. The DID should specify whether the test procedure is to be written in ATLAS or not. It should specify the form in which the TRD should be written to support the development specification. In most cases the contractor should be consulted since he will prepare the development specification.

If the UUT is designed and built by a subcontractor, the TRD should be prepared by the subcontractor in accordance with explicit direction from the prime contractor. These instructions should be a part of the contractual arrangement with the subcontractor.

5.5.2.6 Interface Design Description (No Applicable DID). Interface design is of more than passing interest in computer program development. When a project requires more than one or two programmers, exact interface definitions between programs and between program components become of prime importance in communicating between programmers. Interface design is a computer program system engineering task. It is the framework within which the various programs and components exchange information. Data base design is integral to interface definition. Interfaces can be considered at two levels: (1) interfaces between a computer program and external devices through I/O channels (primarily control software), and (2) interfaces betwen computer programs and computer program components. Both are of vital importance during development and maintenance phases. Internal interfaces affect only the computer program designer and maintenance personnel, external interfaces affect other organizations.

Experience has shown that interface definitions tend to be overlooked when they are emphasized in the development process. This lack of definition leads to confusion among the programmers and between programmers and other system designers. When given proper emphasis by preparing separate interface documents,

a better definition has resulted; it has been easier to review, and interface information has been easire to locate and use for troubleshooting and maintenance.

Interface descriptions for test software are controversial. Some feel that the subject is adequately covered in the TRD. However, if test software is to be the result of a preconceived design and not just a collection of TRDs it will be specified in a Computer Program Development Specification and there will be interface descriptions that are pertinent to the computer program being developed, (see Figure 5.5-2 and paragraph 5.5.2.4.2). These interfaces are not covered in the TRD.

The application to control and support software is more traditional. The application depends on how much new design is required. Interface documentation may not be required if all control software and support software are off-the-shelf, and the vendor's documentation is adequate. If changes are planned or anticipated, an interface description must be provided.

The interface design description document includes detailed description of all external interfaces. The exact format, frequency and methodology for passing and receiving data are included. Internal interface descriptions include the data base structure, methodology for passing and receiving data, detailed descriptions of files, and of the indivdual data elements. Included are data types; e.g., array, files, items, etc.; data characteristics; e.g., floating point, integer, binary, BDC, etc.; data identifiers; size; i.e., number of bits, bytes, words; identification of programs that set or use the data items; and a description of each data item. The organization of data items into files or other data structures is also shown with names, dimensions and other distinguishing characteristics of the data base files.

In current ATE acquisitions these data are included as part of its product specification. There are no DIDs describing computer program interface design descriptions. Therefore, a unique DID must be generated and submitted to the Command Data Management Office for approval by the Contractor Data Management Review Board. It must be approved before it can be placed on contract. In the meantime, the sections in the product specifications can be strengthened by tailoring the existing DIDs, DI-E-3120 or by locating a DID that primarily addresses interface definitions and tailor it for ATE applications, e.g., B-1 Avionics software documentation contains a separate document for computer program interfaces. A unique DID or expanded section of the product specification could be developed, based on the material included in the B-1 Avionics example.

The interface design description document is prepared by the contractor in parallel with the product specification. A preliminary draft is prepared at the CPCI PDR; and a complete draft at the CPCI CDR. Separate PDRs and CDRs may be conducted for each CPCI due to different development schedule requirements.

5.5.2.7 Computer Program Product Specification (DI-E-3120). The product specification includes a complete description of ATE computer programs including logic flows and program listings supported by appropriate narrative. A preliminary draft is prepared for the CPCI PDR, a complete draft is prepared at CPCI CDR and it is delivered at the PCA. Following acceptance, the configuration management product baselie is established. Changes from this time on require Air Force approval. Prior to delivery to the Air Force, the product specification provides a means for baseline control, internal to the contractor's organization, for design reviews and for information exchanges among programmers.

The Computer Program Product Specifica-

tion is prepared in accordance with DI-E-3120. This DID references MIL-STD-483 for format and contents. A separate DID should be prepared for each of the ATE computer program categories since they have unique requirements. The DIDs should be tailored for the unique characteristics of ATE computer programs. Interface design descriptions are addressed; but, as discussed in paragraph 5.5.2.6, should either be expanded or removed and included in a separate document. ATE computer programs lend themselves to a different emphasis depending on which of the three types they are. Test software is produced by converting test requirements from the TRD/development specification into the ATLAS language. The product specification consists primarily of the ATLAS listings with appropriate annotations; and the design of test software CPCI, possibly expressed with logic flows and supporting narrative; and the quality assurance section describing the methods used for validation. Interface descriptions will be included if a separate document is not provided. Support and control software consists primarily of vendor documentation describing the computer programs they provided. Logic flows and listings are necessary for efficient maintenance; they should be obtained if possible. Changes required for the support and control software must be fully documented including development specification, interface description and a product specification. Logic flows, annotated listings and narrative are required in addition to quality assurance requirements.

ATE product specifications must be kept up-to-date if they are to be of value to either the contractor, the developing agency or the maintenance agency. The product specification presents a complete design. Computer code is generated in accordance with the design. Changes are inevitable and are expected. The contractor's approach to handling changes and keeping the draft product specification current are described in the CPDP. Logic flows and computer timing and sizing estimates in particular remain fluid and require effort to keep current. After delivery to the Air Force, it is even more difficult to maintain currency due to the length of time to approve changes through change board action.

The product specification consists of three primary parts: logic flow diagrams, supporting narrative and the program source listings. Care should be taken to assure that these parts can be easily correlated by clearly annotating these parts. The program listing represents the executable computer program code; and the logic flow and the narrative description represents the design. Top down structured techniques may be used in some cases, when this occurs the logic flows may be expressed in a PDL in place of the traditional flow charts. The product specification DID should be tailored to provide this possibility.

5.5.2.8 Computer Program Test Plans/ Procedures (DI-T-3703). Test plans are prepared for each CPCI to show the facilities, methods, personnel and schedules required for validating ATE computer programs from early programmer tests to final acceptance. The test plan includes provisions for all three types of ATE Computer programs. Test plans may be prepared as a single document or separate documents for each CPCI describing how the different CPCIs will be tested and integrated. If schedules are compatible a single ATE test plan is preferable.

Test plans and test procedures are prepared by the contractor, describing in detail the planning, equipment required, test schedules and detailed step-by-step procedures for validation of ATE software in accordance with DI-T-3703. Test plans are prepared in accordance with section 4 of the development specification. In the past, validation of test software has lacked formality. It is essential that test software be qualified in accordance with the development

specification to provide necessary quality assurance provisions. Test plans for test software will describe the methods used for testing, the equipment required and test schedules. Care is required for coordinating the availability of hardware and software facilities. Test plans for control and support software will address how the specified additions and changes will be tested. Preliminary draft of the test plans should be available at the CPCI PDRs; the complete drafts are reviewed at the CPCI CDRs. Test plans should show the entire test plan leading to acceptance of the ATE software. This includes programmer level tests, computer program integration tests, and validation tests.

Test procedures are prepared for each individual qualification test and will specify the test sequence, including identification of the equipment configuration, computer program configuration, equipment setup, step-by-step procedures and expected results. The contractor may provide internal test procedures for lower level tests leading to qualification. These lower level procedures are not listed on the CDRL but may be obtained through the data accession list technique (paragraph 5.4) if desired.

Test plans and test procedures should be prepared in separate volumes. Test plans are normally produced well in advance of test procedures. It may also be more convenient to prepare test procedures in separate volumes depending on the size of the tests. Test procedures for formal qualification and acceptance tests must be approved by the Air Force prior to actual testing. Changes made during testing must be recorded in the test procedure to provide a record of the test as it was conducted. The as-run test procedure is delivered at FCA.

5.5.2.9 Test Reports (DI-T-3717). Test reports are prepared by the contractor to describe the results obtained from qualification tests. They are prepared in accordance with DI-T-3717. They are delivered within a time period following the test completion. The delivery should be specified in block 12 of the CDRL form 1423. The delivery schedule should be expressed in terms related to completion of a test, i.e., delivery required 60 days after completion of test. The results are used as part of the FCA process. Delivery of lower level test results may be obtained using data accession list techniques (paragraph 5.4).

5.5.2.10 Computer Programming Manual (DI-M-3411). The computer programming manual provides instructions to enable experienced computer programmers to prepare, interpret and alter computer programs. These programs are written in a particular machine, assembly, or compiler language for a specific computer. Compiler languagers will include FORTRAN for control and support software and ATLAS for test software. Computer programming manuals are required for each language/computer combination. Vendor manuals are sufficient if they are available. If they are not available a manual must be prepared in accordance with DI-M-3411. Control and support computer programming manuals are normally provided by the ATE computer manufacturers.

The ATLAS compiler may be provided by a vendor or may be developed (either partially or wholly) by the contractor. If it is developed or modified by the contractor, a programming manual is probably of greater importance to maintenance personnel than to the software developers. If the ATLAS compiler is developed by the contractor using his own funds, a problem of data rights may surface. It is important that data rights are obtained for all programs and data that are necessary for computer program maintenance. Data rights are subject to negotiation and must be obtained for all computer program documentation that is required for maintenance support.

5.5.2.11 User's Manual (DI-M-3410). User's manuals are developed to provide computer program users with functional descriptions, usage instructions and descriptions of input data requirements and output products for the computer program. In addition, information for computer operations is provided in terms of procedures for initiating the program, terminating and restarting it as well as descriptions of operator inputs, outputs, formats, and interrelationships. System generation procedures should also be addressed, describing them in detail to assure identical results can be obtained from separate system building activities.

The user's manual is an output of the development effort and is prepared by the development contractor for delivery at PCA. Drafts should be available prior to formal test and integration to support these activities. It provides instructions for proper use of the program in the operational and support phases as specified in DI-M-3410.

The DID offers a comprehensive organization for this manual. It is necessary to tailor the DID for each specific ATE application. This may involve a DID for each CPCI or for each type of ATE software. The specific application is dependent on the amount of development work to be done, usability of vendor manuals and the amount and type of maintenance anticipated. User manuals obtained from vendors will probably not meet requirements of DI-M-3410, but may be suitable for the intended user. This problem may be resolved by having the manuals reviewed by personnel of the eventual user and/or support organizations.

If TDSP techniques are used, the TDSP philosophy should be provided. If a PDL is used in place of traditional flow charts, the PDL philosophy should be included to enable program maintenance personnel to understand the specific technique used.

The relationship between a user's manual and a Technical Order (T.O.) needs to be explored for test software. Test software should be designed to provide a structure that integrates the separate test procedure produced from the TRDs. The T.O. is a detailed procedure for performing a test on a UUT. The user's manual contains some applicable material that may be used to assist in preparing the T.O. However, the user's manual is prepared to assist computer program maintenance and operations. The two, T.O. and Users Manual, are separate and distinct documents.

5.5.2.12 Computer Software Maintenance Manual (DI-M-5118). The Computer Software Maintenance Manual provides a maintenance programmer with information to enable modification or maintenance of computer programs delivered under a contract. DI-H-5070 is normally used in conjunction with this item. DI-H-5070 requires the delivery of supporting computer programs that may be used by its contractors, as tools for more efficient means of debugging and updating this computer program. Tailoring for a specific application is required.

These DIDs are shown here as an alternative consideration to the User Manual (paragraph 5.5.2.11). The maintenance manual and the user's manual contain much redundant information. In fact the maintenance manual contains information that is also redundant with the product specification. It is doubtful that both manuals should be required. The user's manual is a more complete document and contains a wide variety of information. Either manual may be used, when carefully tailored to the application at hand by combining information from all three DIDs, reducing the scope or a com-

bination of both. The user's manual is the more comprehensive; therefore it should be the one used.

5.5.2.13 Version Description Document (DI-E-3121). The purpose of the VDD is to identify the exact configuration of ATE computer programs and interim changes to them. It is used to identify each version, and accordingly, accompanies each version of ATE computer program and each release for interim change.

The VDD is prepared by the ATE contractor in accordance with DI-E-3121. The DID essentially refers to MIL-STD-483 for format and content. A VDD is delivered to the Air Force at PCA for each CPCI that provides an exact description of the ATE software configuration delivered at that time.

During the installation and operational phases of the computer program development cycle, many different computer program versions are generated and used. Several of these versions may be in use concurrently. Configuration management of computer program versions are generated and used. Several of these versions may be in use concurrently. Configuration management of computer program evolution can be a monumental problem if there is no means for identifying the separate versions. Basically a new version is created whenever any change is made. The VDD covers the entire CPCI delivered, including vendor supplied sofware. The VDD provides the same function as a top level hardware drawing in that it identifies the exact version of each component that makes up the computer program. The exact design and code changes to a specific version of a computer program component are described in the product specification complete with logic flow and program listings; however, a composite program configuration consisting of specific versions of program components may be very difficult, if not impossible, to identify by the product specification. The VDD should also identify the exact configuration of all the computer programs required to generate and maintain the deliverable computer programs. This includes the version identifiers of compilers, assemblers, link editors and all other computer programs used in the process.

5.5.2.14 Configuration Mangement Plan (DI-E-3108). The CMP is prepared by the contractor to describe his assignment of organizational responsibilities and the procedures used in the accomplishment of the specific configuraton management requirements as stated in the SOW. The CMP is prepared as part of the contractor weapon system proposal and may become contractual after contract award and approval by the Air Force. It is written for the entire weapon system development, possibly several years before the ATE activity is seriously considered. Configuration management plans are established at that time. Configuration management for the operational software will probably be addressed. In all probability ATE software will not be addressed, unless specific requirements are written into the DID. The basic DID is DI-E-3108. Procedures unique to ATE computer programs should be written in the ATE CPDP.

5.5.2.15 Configuration Index (DI-E-3122). The configuration index for a computer program is part of an integrated approach to configuration management in accordance with Appendix XIV of MIL-STD-483. It provides the current status for specifications and selected additional documents (such as test plans/procedures, test reports, user's manuals and VDDs) whose content is dependent on current ATE software configurations.

The configuration index is prepared in accordance with DI-E-3122 and MIL-STD-483. It is prepared by the contractor as an on going record of changes to the affected documents. Document status is summarized by dates of issue,

document numbers and titles, ECPs, SCNs, and revision identification associated with each issue or document change resulting from accomplished changes.

The configuration index is established as part of the prime weapon system contract. The initial CDRL should be examined to assure that the configuration index is on the list and that the DID provides for and does not exclude, either implicitly or explicitly, ATE computer programs of all categories. If adequate provisions are not made for ATE computer programs at the time the ATE CCP is being negotiated, a new DID can be added specifically for ATE.

5.5.2.16 Change Status List (DI-E-3123). The change status list is supplementary to the Configuration Index (paragraph 5.5.2.15). It descrbes the status of all proposal changes to the weapon system for which the contractor is responsible and for which existing documentation is listed in the configuration index. It is prepared by the contractor in accordance with DI-E-3123 and MIL-STD-483. It is a continuous record of the status of proposed and approved changes.

As with the two previous documents, the change status report is identified in the prime weapon system contract and applied to the entire weapon system. ATE engineering, while not directly involved at that time, should review the CDRL and the referenced DIDs to assure the existence of the change status report and that ATE computer programs are not inadvertently excluded. If ATE computer programs are excluded a new DID can be added at the time the ATE CCP is being negotiated.

5.5.2.17 Engineering Change Proposal (DI-E-3128). The ECP is the vehicle used to prepare, process and incorporate class I engineering changes to the applicable configuration management baseline, i.e., development specification or product specification. It is usually prepared by the contractor and must be approved by the Air Force. It is prepared when a change is considered appropriate and in accordance with DI-E-3128.

5.5.2.18 Specification Change Notice (DI-E-3134). The SCN identifies a proposed change to a contractually applicable specification and, after approval, provides a record of the change and the associated ECP. The SCN is prepared by the weapon system contractor whenever an engineering change is proposed and is included as part of the ECP package. The SCN is prepared in accordance with DI-E-3134 and MIL-STD-483. The SCN is identified in the prime weapon system CDRL and remains applicable throughout the development and installation phases and includes ATE computer programs, unless specifically excluded.

5.5.2.19 Data Acquisition List/ Internal Data (DI-A-3027). The data accession list is an index of data that is available upon request. It identifies all contractor internal data which have been generated by the contractor in compliance with the work effort described in the SOW. The data accession list is prepared in accordance with DI-A-3027.

5.5.2.20 ATE Documentation Summary. ATE computer programs have several unique characteristics which should be considered during selection of a CDRL. These are:

a. ATE computer program activity occurs late (up to several years) in the development of a weapon system.

b. ATE activity is not prominent at the time the initial weapon system CDRL is being developed and thus may be overlooked.

c. CDRL items that are peculiar to ATE computer programs must be negotiated with the contractor when the ATE CCP is being developed.

d. A significant portion of the information for ATE computer program documents may come for subcontractors.

e. In the past, ATE test software has been developed as a T.O. order rather than a CPCI.

5.5.2.20.1 ATE Time Lag. The time lag between the weapon system development activity and ATE development activity results in several problems that require aggressive action on the part of ATE engineering personnel. Since ATE computer program activity is a long way in the future, ATE engineering activity will be a part-time assignment at best. Responding to the data call and keeping current with the proposed and final CDRL can only be accomplished by initiating the action and making sure that follow-up activity is not overlooked. Data items that are unique to ATE computer programs will not be included in the initial CDRL; however, ATE engineering should examine the DIDs for those items that are relevant but not unique to ATE computer programs. These documents are TRDs, CMP, configuration index, change status report, ECP, SCN, and the data accession list. Some current programs are engage in ATE software planning prior to the weapon system RFP. This practice should be encouraged. While many specific details are missing, coming to grips with the relationships between TRDs and development specifications is certainly possible.

5.5.2.20.2 ATE Computer Program Unique Documents. The documents that are unique to computer programs are identified during the preparation of the ATE CCP. The list must be negotiated with the existing contractor(s). The contractor(s) will be more independent in their demands at this time than when negotiating the prime contract. They will probably have different ideas as to which documents should be prepared as well as the contents and formats. When evaluating their requests (demands), one must always keep the purposes of documentation in sight and determine whether or not these purposes are satisfied. Inadequate documentation may be much more expensive than too much documentation when total life cycle costs are examined. Contractor formats may be acceptable and may satisfy documentation purposes at a lower cost. Contractor formats. Standard formats are preferable, but contractor formats may be acceptable if a distinct advantage can be shown. Good ideas and better methods of data presentation should be used to update the present set of DIDs and in the long run to minimize contractor unique formats.

5.5.2.20.3 Subcontractor Data. Much of the data required for ATE computer program documentation may originate with a subcontractor. Some TRDs may be prepared by a subcontractor building a particular unit to be tested, ATE equipment and computer programs may be provided by a vendor or computer manufacturer, some support software may be provided by yet another vendor. Control of subcontractor data is vital to the efficient development, operation, and support of ATE computer programs.

When a weapon system component is manufactured by a subcontractor, the subcontractor should be required (by contract) to provide a TRD or equivalent. The contents and format of the TRD for ATE should be compatible with the ATE Computer Program Development Specification, as described in paragraphs 5.5.2.4 and 5.5.2.5. The TRD and development specification DIDs should be specifically tailored for this purpose.

Vendor data for computing systems and computer programs present another problem. First, whether the data is available at all; second whether it is compatible with the need, and third, whether the vendor will make it available. These factors should all be considered when selecting the ATE equipment. The purchase agreement should include stipulation as to what docu-

mentation is required and when it should be delivered. Data rights must be negotiated such that all data needed for operation and maintenance can be obtained, used and maintained.

5.5.2.20.4 T.O. Versus CPCI. Historically, ATE test software has been acquired as a T.O. DODD 5000.29 currently requires that they be acquired as a CI. This implies more documentation and tighter controls for the development of ATE computer programs. Development of test software is probably further removed from the computer program development organization than other types of software. Hardware designers write test requirements, test engineers may convert the test requirements to ATLAS statements and the software development organization may provide configuration management techniques. The diverse participants make it difficult to control and, thus, more highly susceptible to abuses. It is also for this reason that controls such as adequate documentation, testing and configuration management are needed. These are all attributes of developing computer programs as CPCIs. All required computer program documentation should be specified in the CDRL. The T.O. should be used as an application of the program such as the UUT test procedures described in paragraph 5.5.2.10.

Section 6.0 DOCUMENT REVIEW AND APPROVAL

Following the selection of a proper CDRL there are still important engineering functions to be performed. A properly designed computer program documentation scheme provides pertinent documents at key milestones in the development process. Drafts of many of the documents are generally produced long before delivery to the Air Force. The drafts are reviewed at such milestones at PDR, CDR or prior to the beginning of qualification testing. This provides the opportunity for assessing the development status of the computer programs and evaluation of the documents themselves at an early date. This section addresses the tracking of the computer program development status through documentation, early evaluation of the required documents and change control performed by both the contractor and the using and support agencies.

6.1 COMPUTER PROGRAM STATUS

Computer program documentation, phased for completion at appropriate times in the computer program development cycle, provides an excellent means for determining contractor program status. This concept embodies the development of computer program documentation in parallel with that of the computer program itself. Each of the phases in the computer program development cycle produces documentation representative of that particular phase. Figure 6.1-1 shows this relationship for both TS and ATE computer program development. The figure shows delivery of the document to the Air Force as well as the release of review drafts. It should be noted that the references to PDR, CDR and FCA/PCA are CPCI related. Each CPCI or CI has a schedule with its specific milestones. The milestones may be integrated for the several CPCIs but for the purposes of the figure they refer to the CPCI.

6.1.1 Analysis Phase

The emphasis in the analysis phase focuses on the analysis and specification of computer program requirements, planning for the development process and a preliminary design. TS and ATE acquisition programs differ in startup methods since they are usually different types of contracts.

A TS system is usually acquired under a separate contract. It is often preceded by a competitive study phase. The study phase is part of the analysis phase and results in a TS system specification, a contractor proposal and a computer program development plan. The proposal and the CPDP are evaluated and are used as part of the source selection process. After award of the contract, the system specification and the contractor proposal are placed on contract; the CPDP may also become contractual (see paragraphs 5.5.1.2 and 5.5.2.3). The emphasis then shifts to preliminary design and test planning activities to be completed and reviewed at PDR.

ATE acquisitions are not as clear cut. ATE development is often contracted as an extension of a prime weapon system contract and is dependent on tasks performed previously by different organizations such as the ORLA and the preparation of the SERD and the SEP. The documentation products of the analysis phase are essentially the same as the TS a CPDP, development specification, preliminary product specification, test plans and preliminary interface documents. A significant difference is that the development specification is prepared by the contractor. The development specification is usually placed under Class I change control after approval by the Air Force and becomes a contractual document. The CPDP may also be placed on

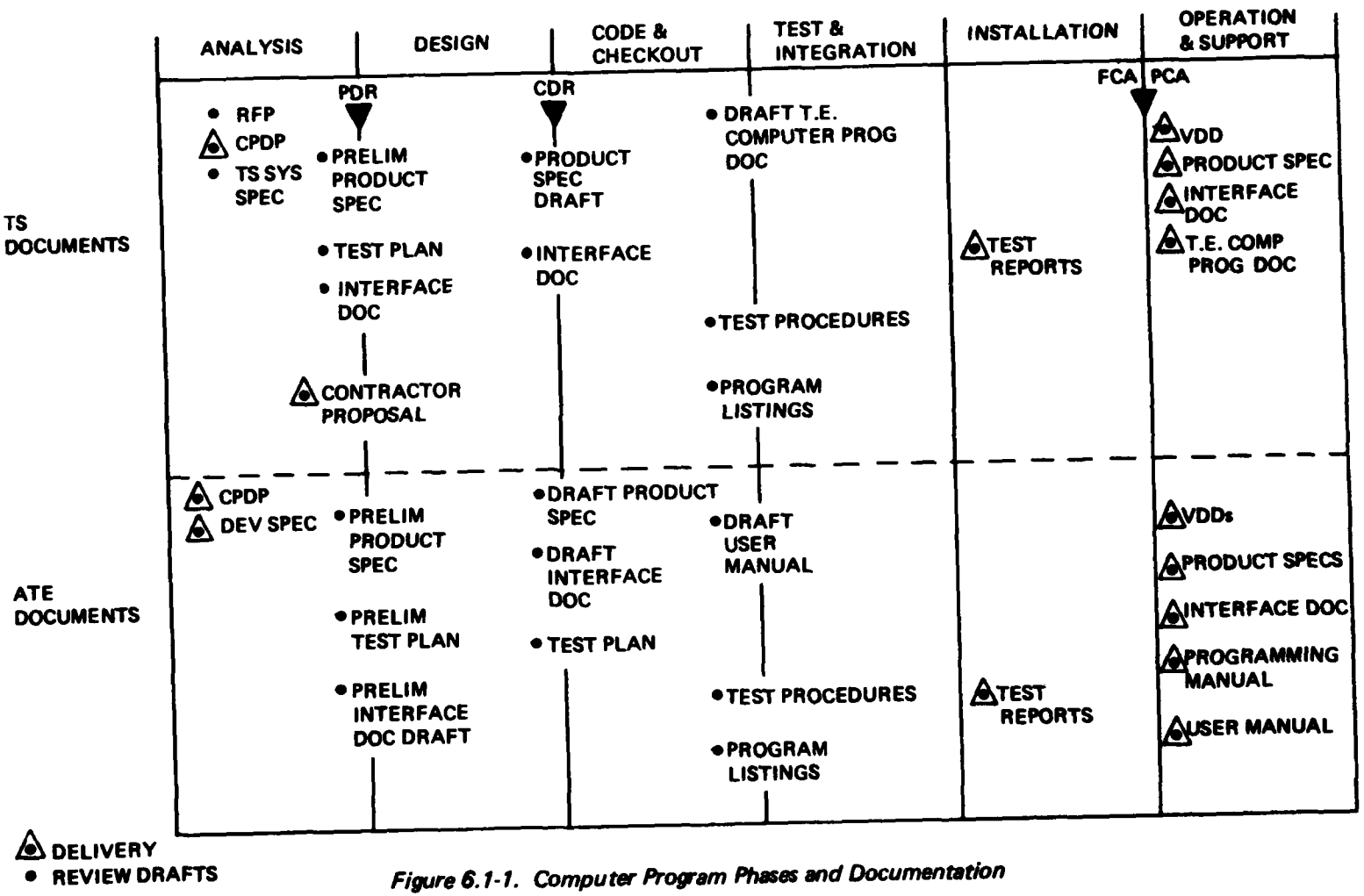

Figure 6.1-1. Computer Program Phases and Documentation

contract as described in paragraph 5.5.2.3. PDRs may be held at different times for the different ATE software categories depending on the schedule.

TRDs are developed as a part of the weapon system contract and do not show in the computer program development phases. Ideally they would be developed in the analysis phase; but, in reality they may not be completed until well into the design phase. The relationship to the TRD and the test software development specification is described in paragraphs 5.5.2.4 and 5.5.2.5.

The PDR represents the completion of the analysis phase for a CPCI or CI. The documentation produced at that time provides excellent material for review and assessment of the progress made by the contractor toward fulfillment of the contract. Contractor planning can be reviewed to determine whether plans are realistic in relation to the progress made to date. The maturity of his preliminary design and interface definition may reveal problem areas that lay ahead. His understanding of the problem to be solved may be revealed through the application of his design to the requirements for the computer programs. Good documentation at this point is indicative of a well-managed software development. Poor or incomplete documentation may reveal future problem areas or that more time is needed to complete this phase before preceeding to the next phase.

6.1.2 Design Phase

The emphasis in the design phase is to achieve a fully developed design which can be translated directly into computer code. This phase culminates in the CDR. Draft product specifications and interface design descriptions should be completed. TRDs are complete at this time and available for review for ATE test software. TRDs may be partially written in the ATLAS language. These documents can be used as baselines for contractor internal configuration management practices. Test plans should also be completed. Review of these documents at CDR will reveal the maturity of design and the readiness for beginning the code and checkout phase. Again poor or incomplete documentation may be indicative of poor design or poor management. A decision to move to the code and checkout phase or continue in the design phase can be made intelligently based on the documentation presented at the CDR.

6.1.3 Code and Checkout Phase

The emphasis in this phase is producing computer code and checking out individual program modules. Documentation produced during this phase is the computer program listing, an update of the product specification and test procedures. Air Force review of the listing at this point is not vital. The program listing provides a vital element in the identification of the computer program configuration. A parallel effort being performed during this phase is the development of test procedures for qualification of the computer programs. These procedures should be prepared by a contractor organization that is independent of the development organization. Test procedures are based on the program design described in the product specification and the requirements specified in the development specification.

Completion of test procedures, the program listings and the updated product specifications is required for continuation into the test and integration phase. Lack of either should be sufficient reason for delaying validation testing. Validation testing cannot be performed without approved test procedures and should not be performed without adequate internal configuration management techniques.

The CPDP should be reviewed at this point to assure that the contractor organization is same as described and

that the independence described in the CPDP is maintained.

6.1.4 Test and Integration Phase

Significant documents produced during this phase are updated program listings, test reports that show the results of all qualification tests, and a draft of the user manual. Test reports are significant inputs to the FCA. These documents are the primary evidence presented at FCA for evaluating whether computer programs perform according to the development and product specifications. A draft of the user's manual should be produced and validated during this phase. Preparation of the user manual during this phase permits enough time to validate the procedures contained therein during both this phase and the installation phase.

Again, the CPDP should be reviewed to assure that the configuration management activities are in accordance with the CPDP. Configuration management is of great importance during this phase to establish the integrity of the computer programs that are eventually delivered.

6.1.5 Installation Phase

The installation phase culminates in the FCA and the PCA. At this time the computer programs have been installed at the government facility and all documentation is complete and current. Review of the documentation should be for completeness and suitability for use in the operation and support phase. It is at this time that the documentation is delivered to the Air Force and the product baseline is established. PCA and FCA may be moved up to the completion of the test and integration phase if there are no significant differences in the installation in which the computer programs are to be used.

6.2 DOCUMENT EVALUATION

Delivered documents will vary in content and quality regardless of what is prescribed in a DID. These differences depend on the level of importance the contractor gives to documentation, the skill of the engineer preparing the documents, the explicitness and applicability of the DID and the insistence of the project office in demanding quality documentation. The importance of good documentation has already been discussed; it is essential for efficient maintenance in the operation and support phase. Because of this variance in quality, each of the documents on the CDRL should be reviewed and should be accepted only if the document satisfies the purpose of the intended users. It must be understood that good documentation is expensive and is sometimes a negotiable item. Since the primary use for delivered documentation is for operation and support, the appropriate commands should be involved in any decision to delete requirements for particular documents from any contract.

An important factor in both the quality of a document and its evaluation is the DID itself. The importance of tailoring the DID for the specific application has been discussed in the previous section. If a DID is confusing, contains irrelevant material or is not applicable, the resulting documents will surely suffer.

As shown in figure 6.1-1, most of the documents that are to be delivered appear in draft form prior to official delivery. This provides an opportunity for reviewing the documents prior to delivery at PCA. The development specifications for ATE software and the computer program development plan are partial exceptions. They are written and delivered in the early stages of development. Review of these documents is

automatic because they define contractual obligations for computer program performance and the plan for developing the software. These documents receive much attention and their development is closely monitored and negotiated.

6.2.1 Evaluation Criteria

Each document should be evaluated according to the following criteria:

a. Does it satisfy the DID?

b. Is it clearly and concisely written?

c. Is it technically accurate?

d. Does it completely satisfy the purpose of the document?

e. Are interfaces clearly defined?

6.2.1.1 Does the Document Satisfy the DID? DIDs are descriptions of documents that are required, by contract, to be delivered to the Air Force. Most DIDs state explicitly the format and content of the document. CDRL documents should be evaluated primarily as to whether the document being reviewed complies with the DID. Most contractor-prepared documents will comply with the format, at least in the paragraph or section headings. The important thing is to determine whether the intention of the DID is satisfied. Assuming the DID is properly written the intention and use of the document should be clear. If the document does not satisfy the intention of the DID it should be returned to the contractor with explicit comments as to why it was rejected and where it did not comply with the DID.

6.2.1.2 Is the Document Clearly and Concisely Written? Another major point to be evaluated is whether the document can be easily read, understood, and used by the eventual user of the document. Documents should be written in such a manner that procedures and descriptions are clear and unambiguous. Text should be written in simple English with terms familiar to the user. Logic flows, whether they are flow charts, PDL or some other approved form, should be easy to follow and should conform to a recognized standard. (Standards published in the CPDP and approved by the project office are sufficient.) Logic flows should be well annotated and should correlate directly with the narrative and program listing. In turn program listings should be sufficiently well annotated to permit a direct correlation to narrative and logic flows. Requirements expressed in development specifications should be clearly stated and unambiguous. Eash requirement should be singularly stated singularly identified and should be testable.

6.2.1.3 Is the Document Technically Accurate? Technical accuracy may be difficult to evaluate by other than engineers who have been closely following the computer program development process. Special emphasis should be placed on the documents that describe the as-built/as-delivered computer programs and the procedures for maintenance and support. The test process should verify that the computer program product specification accurately describes the delivered computer program. Operating procedures should also be validated during the test process. System generation procedures should be accurately described and proven during the test and integration phase when the software system generation is performed between testing periods. Assessing technical accuracy requires familiarity with the computer programs, and knowledge of tests performed and validation of the procedures described.

6.2.1.4 Is the Purpose of the Document Satisfied? The purpose of most of the computer program documents is either stated in the document or is easily understood by the title. A document may have multiple users, each with a different purpose in mind. The reviewer

should attempt to place himself in the user's position to evaluate whether all the purposes of the document are satisfied. For example, the product specification is used for configuration management purposes as the configuration identification of the product baseline. It is also used by support personnel as the primary document describing the computer program structure for maintenance purposes. The use and users should have been identified in the CDRL selection process (paragraph 5.1). If the document does not satisfy user requirements the DID should be examined to determine if it needs to be modified. If the DID needs to be modified a contractual change may be required to respond to the DID modification. The change should be noted and included in DIDs for similar future acquisition.

6.2.1.5 Are Interfaces Clearly Defined? Poor definition of interfaces is poor design and leads to confusion during the design, coding, test and integration and support phases. Interfaces between computer program (CPCIs) and hardware external to the program are vital to good communication between different groups. This includes data formats, data rates, methods of initiating data transfer and use of I/O channels. The data base is the primary means of transferring data between computer program components. The tables, files and other structures should be identified and described in detail. Access methods, names, and naming conventions should be defined.

Document evaluation should never be taken lightly. Before a document is accepted by the Air Force it should have been comprehensively reviewed and all deficiencies corrected. Table 6.2-1 is a summary check for document evaluation.

6.3 DOCUMENT REVISION

Once a document is completed and released, it should be subjected to some measure of formal change control to prevent indiscriminate revision. This control may be entirely internal to the contractor or may require project office action. Figures 6.3-1 and 6.3-2 show the evolution of the development of TS systems and ATE computer program documents and the change control categories to which they are assigned. In general, documents are maintained under contractor control methods after they have been released and remain so until formal delivery to the Air Force. After formal delivery, changes to documents identifying computer program configuration baselines and maintenance operating instructions require approval by the Air Force. The PDR, CDR, FCA and PCA shown on the figure are representative of a single CPCI or CI. Each CPCI or CI is scheduled separately with its own milestones because the need, availability and resource may differ for each CPCI.

6.3.1 Document Change Control

Two levels of change control are applicable to the documents produced for computer program development. They are formally desingated as Class I and Class II. Complete definitions of these two change classifications are found in MIL-STD-483. In general, Class I changes require Air Force approval and Class II changes require only Air Force concurrence that the changes are not Class I. Thus, Class II changes are controlled by the contractor. Figures 6.3-1 and 6.3-2 show the transition points from contractor control to Air Force control for the primary documents described in this guidebook. In the earliest stages of development, changes to the Computer Program Development Specification, the CPDP, the CMP and, for TS systems, the contractor proposal require Air Force approval. As the remaining documents are written and released they should be placed under some formal means of control by the contractor. The remaining documents are delivered to the Air Force at PCA. Those to be used later in the Operations and Support phase are then placed under Class I change control.

Table 6.2-1. Document Evaluation Checklist

1. Does the document satisfy the DID?
2. Is the document written clearly and concisely?
3. Are procedures described in a logical step-by-step process?
4. Are all statements clear and unambiguous?
5. Do logic flows clearly describe the process intended?
6. Is there a clear correlation between logic flows, narrative text and program listings?
7. Are standards for logic flows defined?
8. Are requirements expressed clearly and singularly?
9. Are requirements testable?
10. Is the document technically accurate?
11. Do test results confirm the design description?
12. Have operating procedures been validated?
13. Have system generation procedures been validated?
14. Are all purposes of the document satisfied?
15. Have all document users been identified, have their needs been considered?
16. Are all external interfaces explicitly defined?
17. Have all data base elements been defined and adequately described?
18. Is it clear how transfer of data, whether external or internal to the program, are controlled?

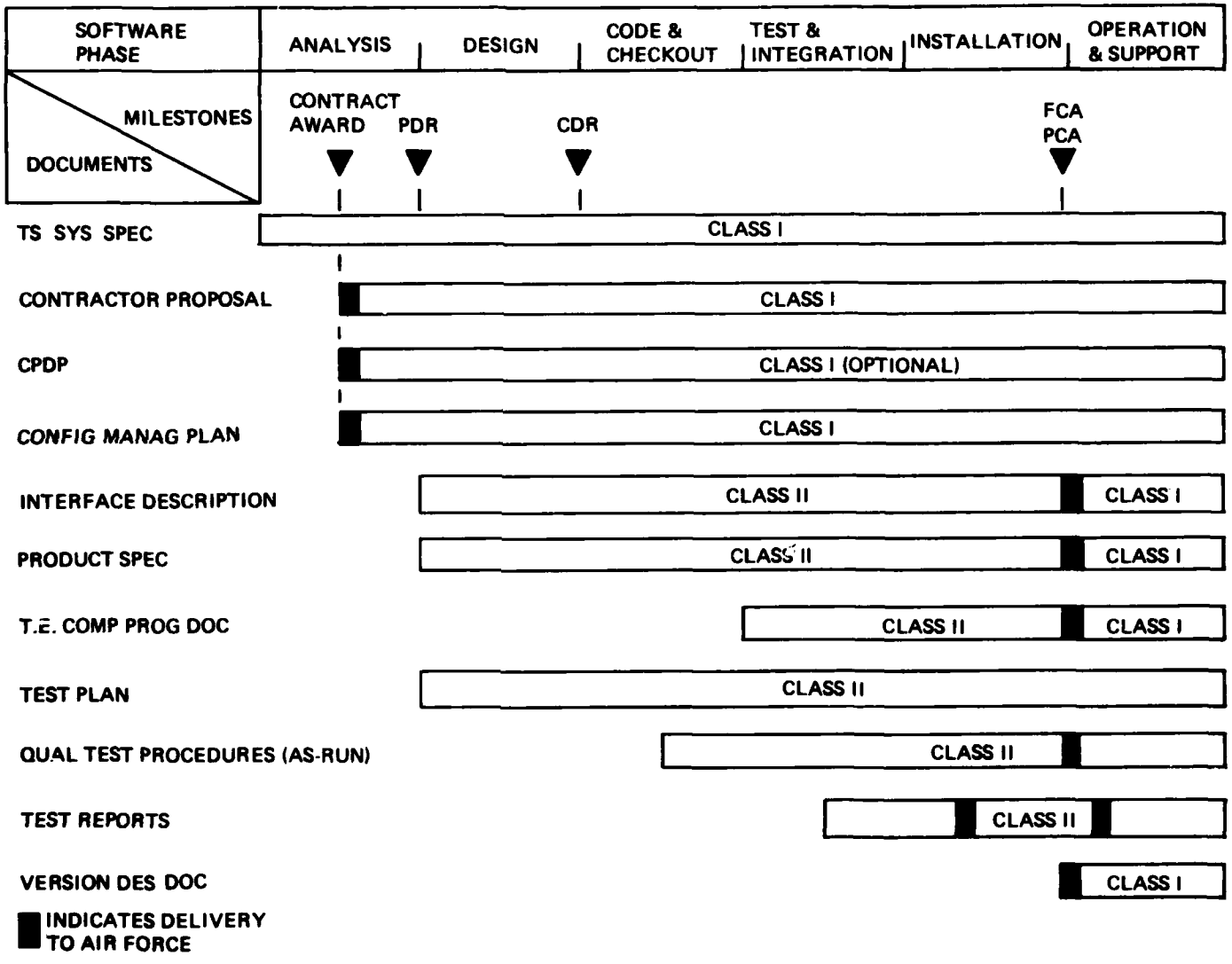

Figure 6.3-1. Trainer Simulator Document Change Control

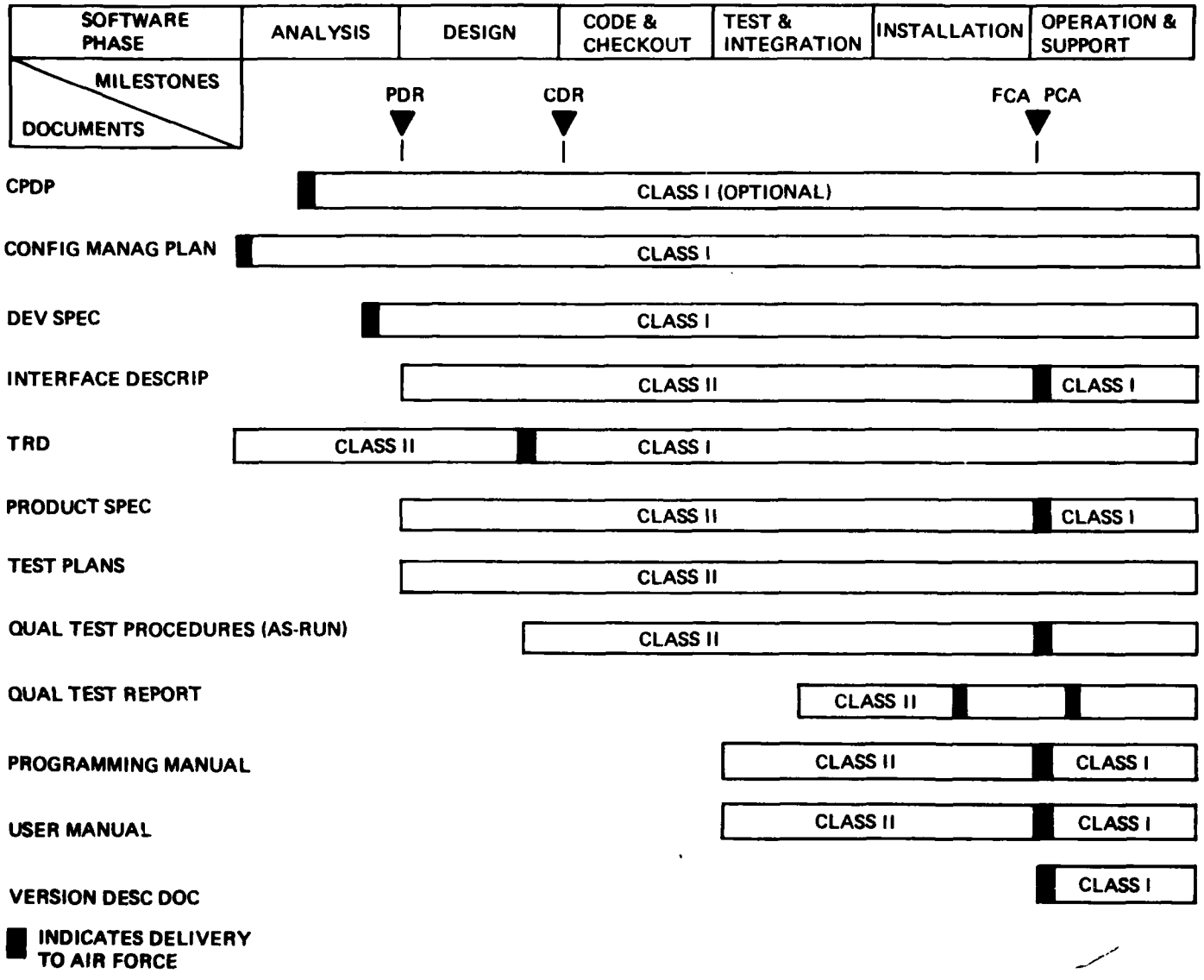

Figure 6.3-2. ATE Document Change Control

6.3.2 Change Control During Development

During the development process only those documents relating to defining the allocated baseline and planning for computer program development and configuration management are under Class I control. ATE development specifications are normally generated by the contractor and, upon approval by the Air Force, are placed under Class I change control. The system specification and the contractor proposal provide the equivalent baseline for TS systems. The CMP and the CPDP which may be generated as part of the contractor's proposal (TS) or early in the development phase (ATE) and upon approval become part of the contract. Changes to these documents frequently affect cost, performance or both. Changes are initiated by an ECP, usually by the contractor. They are reviewed and approved (or disapproved) by the contractor change board and submitted to the Air Force change board for review and approval (or disapproval). Upon Air Force approval the affected documents are updated by SCN or Document Change Notice (DCN) and appropriate action taken.

As the remaining documents are developed and released, change control is in the contractor's hands. It is important that the contractor's document change control procedures are known and observed. These procedures should be provided in the CPDP. The contractor may have several levels of Class II classification permitting efficient processing for document and design changes. The lowest level changes may require only approval by the software supervisor, the higher levels by the program change board. It is particularly important for computer program design documentation to be kept current with the computer program code during the test and integration phase to enable accurate tracing of the configuration of the programs finally validated and to assure that the code matches the design documentation. A contractor version of a VDD could be used effectively to trace these changes.

6.3.3 Changes During the Operation and Support Phase

Changes during the operation and support phase are complicated by the fact that TS systems and ATE may be installed at several sites. If strong configuration management techniques are not imposed this may result in different versions of the computer programs at the operational sites. Changes to computer programs (code) and their documentation should be controlled from one central point. Operation and support of the computer programs during this phase is normally provided by Air Force personnel but may also be provided by a contractor.

Change procedures are similar to Class I procedures used during development. Changes are normally requested by the using command when discrepancies are discovered, when design changes are needed to improve operations or performance, or when there are changes to the weapon systems being simulated (TS) or changes to the units being tested (ATE). Approved requests are passed on to the support command or contractor for incorporation into a new version of the computer program. Documentation changes should always accompany changes to the computer program. The new version should not be released until documentation is complete and available to all users. The support command is the responsible organization for maintaining both the computer program and the program documentation.

Section 7.0 DOCUMENT USAGE

Document usage, one of the factors in the selection of an appropriate CDRL, was discussed in Section 5.0. It is important that each document requested by the CDRL have a specific purpose and that it is needed by the Air Force. That is to say, the CDRL should be the result of a great deal of thought and design. The primary consideration is the use that will be made of the documents by the Air Force. Computer program documentation, whether it is prepared by the Air Force or by the development contractor, is prepared for one of the uses listed below:

a. System requirements and acquisition management.

b. Procurement

c. Configuration management

d. Engineering

e. Test

f. Operation and support

Documentation for the first two uses is usually prepared by the Air Force and the last four by the development contractor. Documents used for these purposes are discussed in the following sections. Documents that have multiple purposes will be discussed in more than one category. Since specific documents are prepared for the same purposes, whether for TS or ATE computer programs, they are discussed together. Different emphases are highlighted where necessary.

7.1 SYSTEM REQUIREMENTS AND ACQUISITION MANAGEMENT DOCUMENTS

Documents prepared for this use are the ROC, PMD, PMP, CRISP, and the CPDP. These documents are all prepared by the Air Force with the probable exception of the CPDP. The CPDP may be prepared by the Air Force or more commonly by a contractor. These documents are used by the program manager and other participating Air Force organizations to define program concepts, agreements and planned action.

The ROC and the PMD define overall system requirements and provide for (1) agreements between the using, development, and support commands regarding those requirements; (2) management responsibility for the acquisition of subsystems containing computer equipment and computer programs; and (3) for the integration of computer programs and computer equipment into overall systems. The ROC and PMD are very likely prepared specifically for TS acquisition; thus, management attention is focused on the TS and the computing hardware and computer programs. Normally, ATE is included in the ROC and PMD for an entire weapon system and since the time between the ROC and ATE acquisition is great, few specifics are included.

The PMP, CRISP and CPDP are the primary documents for acquisition management. The PMP is prepared specifically for TS system acquisitions and for the weapon system for ATE acquisitions. The CRISP and the CPDP are written specifically for the acquisition of TS and ATE computer programs. When ATE is added to the weapon system contract, the PMP must be updated. The PMP provides planning and resource management for the entire TS or ATE system during the development phase while the CRISP provides for computer resource management in the development phase and through the transition to the operation and support phase. The CRISP is a living document and is maintained and updated throughout the computer program life cycle. These documents, PMP and CRISP, provide a plan for the program manager that has been coordinated with the developing, using and support commands.

The CPDP is usually written by the development contractor and describes his plan for developing ATE or TS computer programs. The TS CPDP is prepared as part of the contractor's proposal and can be used in the source selection process. The ATE CPDP is prepared after negotiations are complete on the contract extension. In either case, the CPDP when negotiated and approved by the Air Force can become a contractual document which must be observed by the contractor.

7.2 PROCUREMENT PLANNING DOCUMENTS

Documents prepared for procurement purposes are written by the Air Force and include the RFP and the SFE. The RFP includes the SOW, CDRL, IFPP and TS system specifications. Procurement planning documents are prepared for the TS systems acquisition and are only remotely applicable for ATE systems unless it is acquired under a separate contract. The same documents are also required for a weapon system procurement but probably will not specifically involve ATE.

The RFP is a collection of documents prepared by the Air Force for the purpose of describing the job to be bid. The SOW describes the tasks to be performed by the contractor. The CDRL is a list of documents and other data to be provided by the contractor to the Air Force in fulfillment of the contract. Both the SOW and the CDRL may be modified by the contractor in his proposal. After contract award, the SOW and CDRL will be negotiated and will result in a contractual agreement regarding the tasks to be performed and the data to be delivered. The TS system specification will be used to define the functional and performance requirements for the TS system. These are requirements that the bidders are required to satisfy in their proposal. The IFPP provides detailed instructions as to how the proposal is to be prepared, what it is to cover and what the contents of the various parts of the proposal should be. The IFPP is to be used by the bidders for consistent preparation of proposals that can be evaluated fairly. It should address all the elements by which the proposal is to be evaluated. The evaluation factors are written in the SFE. The SFE is used by the Air Force review team to define how the proposals will be evaluated to ensure a consistent evaluation and award recommendation. The SFE is not available to the contractors but should be reflected in the IFPP.

7.3 CONFIGURATION MANAGEMENT DOCUMENTS

Configuration management is concerned with the identification of configuration baselines, configuration change control and configuration accounting. Documentation used for configuration management must provide for these three attributes. Documents used for configuration management are as follows: CMP, computer program development specification, CPDP, computer program product specification, interface design description, SCN, change status list, configuration index, and VDD.

The CMP is prepared during the proposal period and usually becomes a contractual obligation on the contractor. It is used by the Air Force project manager to ensure configuration management is performed according to the contractor's plan. It is used by the contractor as the master plan for configuration management activities. While it addresses computer programs, at least for the periods prior to delivery to the Air Force, are found in the CPDP. The CMP is developed as part of the weapon system proposal for ATE and as part of the TS system proposal.

The documents identifying the computer program configuration baselines are the computer program development specification, the computer program product specification, and the interface design description document. Once established, a configuration management baseline is placed under Class I change control and

requires Air Force approval for any changes. The development specification when authenticated becomes the CPCI allocated baseline which is the "design to" requirements baseline. This baseline establishes the functional and performance requirements which must be satisfied before ATE computer programs or the TS system is accepted by the Air Force. The TS system development specification is prepared by the Air Force and imposed on the contractor at contract award. Development specifications are prepared by the contractor for each ATE CPCI. The product specification and the interface design description document identify the product baseline which is the "as-built" configuration. These documents describe in detail by means of logic flow diagrams, written text, and program listings, the exact approved configuration of the computer programs delivered to the Air Force. The one to one correlation of the product specification with respect to the computer program code should be established and verified at the PCA prior to delivery to the Air Force.

The Configuration Index, Change Status List, SCN, and the VDD provide the means of identifying changes to the ATE and TS computer program configurations; the identification and status of impending changes and the complete identification, by program component, of all approved configurations. Change control procedures are described in the CPDP and the CMP. Actual changes to the computer program components are recorded in the product specification.

7.4 ENGINEERING DOCUMENTS

Engineering documentation is used for progressive definition of technical performance and for relating performance requirements to the design definition. CDRL documents fulfilling these needs are: preliminary and draft versions of the computer program product specification and the interface design description documents, the TRD and the computer programming manual.

Preliminary and draft product specification and the interface description documents, produced for PDR and CDR respectively, record the progressive definition of the TS and ATE computer program design. Without a written design, there truly is no design at all. The design progressively recorded, provides opportunity for review, comments, and for coordination between designers. Maintaining these engineering data in an up-to-date status is vital for continuing review, comparison with requirements and accurate communication.

The TRD is the result of design engineering and factory qualification testing for a unit to be tested. It specifies the requirements for testing that unit. The TRD does not qualify as a configuration management baseline, but the data contained therein is the basis for ATE test software, thus it is classified as an engineering document. The early TRD data is also used an input to the support equipment analysis that results in the support equipment requirements data analysis.

The computer programming manual provides technical data necessary to enable an experienced programmer to write computer programs for a given computer in a designated programming language. The computer programming manual is specified in ATE CDRL and is a part of the TS. The computer programming manual may not be prepared until the coding and checkout phase is completed but the information is necessary for efficient programming practices.

7.5 TEST DOCUMENTS

Test documentation is used for the qualification and acceptance of equipment and computer programs, and to provide the

basis for testing future modifications. Documents satisfying these uses are test plans, test procedures and test reports. Even though qualification and acceptance of TS computer programs is accomplished at the TS system level, test documentation is necessary for computer programs. Test plans, whether they are for the TS system or for ATE computer programs, provide for the planning, scheduling and coordination of computer programs, computers, and interfacing hardware necessary for conducting qualification testing. Test procedures provide the step-by-step sequence of events for each testing for adequacy and for Air Force concurrence with the test procedures. They also provide a record of the tests and procedures actually performed. Test reports provide the evidence that tests were performed and make a permanent record for pertinent test results.

7.6 OPERATION AND SUPPORT DOCUMENTS

Operation and support documentation is used to operate, maintain, modify and otherwise support the system after acceptance. Documents used for operations and support are as follows: users manual (ATE), maintenance manual (ATE), computer programming manual (ATE), test equipment computer program documentation (TS), computer program product specifications, interface design documents and the VDD. The users manual and computer programming manual for ATE and the test equipment computer program documentation for TS systems provide the technical information needed for the using command to load the computers with the appropriate computer programs, bring it into an operating status, control the operation of the computer programs, intitiate recovery procedures and provide troubleshooting techniques for diagnosing problems. It also provides data for the T.O. used to conduct testing.

The support command uses the users manual and the computer programming manual for ATE or the training equipment computer program documentation for technical information regarding the computer and the programming languages used, maintenance procedure and computer program system generation. The computer program product specification and the interface design documents provide the current design data and descriptions necessary to accomplish changes to the computer programs. The VDD provides the exact configuration of all operating or experimental versions of the TS or ATE computer programs. Approved configurations can be used with knowledge of the exact changes that are included.

Section 8.0 BIBLIOGRAPHY

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AFR 800-6, Statement of Work Preparation Guide

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AFR 800-14, Vol II, Acquisition and Support Procedures for Computer Resources in System, Sept 1975

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Army Reg 700-51, Army Data Management Program, Feb 1973

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ESD-TR-76-159, Air Force Guide to Software Documentation Requirements, June 1976

MIL-D-83468, Military Specification - Digital Computing System for Real-Time Training Simulators, Dec 1975

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MIL-STD-490, Specification Practices, July 1975

MIL-STD-881A, Work Breakdown Structure for Defense Material Items

MIL-STD-1519, Preparation of Test Requirements Document, Sept 1971

MIL-STD-1521, Technical Review and Audits for Systems Equipment and Computer Programs, Sept 1972

T.O. 00-5-1, AF Technical Order System, Nov 1973

RADC-TR-74-300, Structured Programming Series Volumes I-XV, July 1975

SAMSO Exhibit, Computer Program Subsystem Development Milestones, April 1966

Section 9.0 GUIDEBOOK TOPICS VS GOVERNMENT DOCUMENTS CROSS REFERENCE

Figure 9.0-1 is a cross reference matrix showing the guidebook topics and government documents that address that topic. The government documents are identified as well as the sections, chapters, attachments, enclosures, appendicies, etc. in which the topics are found. Whenever a guidebook topic is also the primary subject of a government document, a bullet is used to designate the intersection.

TOPICS \ DOCUMENTS	AFR 67-1	AFR 310-1	AFR 800-2	AFR 800-8	AFR 800-14 VOL II	AFSMC 800-4	AFSCP 800-6	DOD 6000.10-L	DODI 5010.12	DODI 5010.21	DODD 5000.29
AUTHORIZED DATA LIST		SEC A ATT 2			CH 7				SEC 6 INCL 3		
BASELINE MANAGEMENT					CH 4					SEC V INCL 1	
CDR					CH 4						
CDRL		SEC C ATT 3							SEC 6		
CDRL SELECTION		SEC 3									
CHANGE CONTROL					CH 6					SEC VI	
CHANGE STATUS LIST											
CMP					CH 7						
COMP. PROG. DEV. PHASES					CH 2						SEC V
COMP. PROG. DEV. SPEC.											
COMP. PROG. INTERFACES					CH 6						
COMP. PROG. MANUAL											
COMP. PROG. PRODUCT SPEC.											
COMP. PROG. USERS GUIDE											
CONFIG. INDEX											
CONFIG. MANAGEMENT					CH 6					●	SEC V
CONTRACTOR DOCUMENTS		●			CH 7						
CONTROL SW											
CPCI											SEC V
CPDP					CH 3 CH 7						
CRISP					CH 3 CH 7						
CRWG					CH 3						
DATA ACCESSION LIST					CH 7						
DATA CALL		SEC A SEC C			CH 7				INCL 4		
DID		SEC A SEC C						●	SEC 6 INCL 3		
ECP											

Figure 9.0

AFSCP 800-6	DOD 5000.19-L	DODI 5010.12	DODI 5010.21	DODD 5000.29	ESD-TR-78-159	MIL-D-83468	MIL-STD-483	MIL-STD-490	MIL-STD-881A	MIL-STD-1519	MIL-STD-1521	TO 00-5-1
		SEC 6 INCL 3			SEC III							
			SEC V INCL 1				SEC 3					
											SEC 3 APP D	
		SEC 6										
			SEC VI				APP XIV					
							APP VIII					
							SEC 3 APP I					
				SEC V								
					SEC III		APP VI	APP VI				
							APP II					
					SEC II							
					SEC III		APP VI	APP XIII				
					SEC III							
							APP VIII					
			●	SEC V			●					
					SEC III							
				SEC V			SEC 3					
					SEC III							
					SEC III							
		INCL 4										
	●	SEC 6 INCL 3			SEC III							
							APP XIV					

Figure 9.0-1. Guidebook Topics versus Government Documentation (Sheet 1 of 2)

2

TOPICS \ DOCUMENTS	AFR-67-1	AFR-310-1	AFR-800-2	AFR-800-8	AFR-800-14 VOL II	AFSCM 800-4	AFSCP 800-8	DOD 5000.19.L	DODI 5010.12	DODI 5010.21	
FCA					CH 6					SEC VIII	
ILSP				● SUP 1							
ISP				● SUP 1							
LIFE CYCLE PHASES			ATT 3		CH 2		CH 1				
ORLA						●					
PCA					CH 6					SEC VIII	
PDR					CH 4						
PMD			PAR 2 ATT 3		CH 3 CH 7						
PMP			ATT 3 SUPP 1		CH 3 CH 7						
RFP					CH 7						
ROC					CH 3 CH 7						
SCN	●										
SOW					CH 7 CH 8		●				
SUPPORT SW											
TAILORING DIDS		SEC 3			CH 7						
TEST AND EVALUATION					CH 5						
TEST PLAN/PROCEDURE					CH 5						
TEST REPORT					CH 5						
TEST SW											
TO											
TRD											
TS SYS SPEC.											
UNIQUE DIDS		SEC 3			CH 7						
VDD											
WBS					CH 8		CH 1		CH 6		

Figu

AFSCP 800-6	DOD 5000.19.L	DODI 5010.12	DODI 5010.21	DODD 5000.29	ESD-TR-76-159	MIL-D-83468	MIL-STD-483	MIL-STD-490	MIL-STD-881A	MIL-STD-1519	MIL-STD-1521	TO 00-5-1
			SEC VIII				SEC 3 APP XII				SEC 3 APP E	
CH 1					SEC III							
			SEC VIII				SEC 3 APP XII				SEC 3 APP F	
											SEC 3 APP C	
							APP VIII					
●												
					SEC III							
					SEC III							
					SEC III							
												●
										●		
						●						
					SEC III		APP VIII					
CH 1		CH 6							●			

Figure 9.0-1. Guidebook Topics versus Government Documentation (Sheet 2 of 2)

2

Section 10.0 GLOSSARY OF TERMS

Allocated Baseline - The approved configuration item identification. It governs the development of selected configuration items that are part of a higher level specification, e.g., system specification. It is usually defined by the Computer Program Development Specification.

Baseline - An authorized documented technical description specifying an end item's functional and physical characteristics. It serves as the basis for configuration control and status accounting. It establishes an approved well-defined point of departure for control of future changes to system or equipment.

Certification - The test and evaluation of the complete computer program aimed at ensuring operational effectiveness and suitability with respect to mission requirements under operating conditions.

Computer Program - A series of instructions or statements in a form acceptable to computer equipment, designed to cause the execution of an operation or series of operations. Computer programs include such items as operating systems, utility programs, and maintenance/diagnostic programs. They also include applications programs such as payroll, inventory, control, operational flight, strategic, tactical, automatic test, crew simulator and engineering analysis programs. Computer programs may be either machine dependent or machine independent, and may be general purpose in nature or be designed to satisfy the requirements of a specialized process of a particular user.

Computer Program Development Cycle - The computer program development cycle consists of six phases: analysis, design, coding and checkout, test and integration, installation, and operation and support. The cycle may span more than one system acquisition life cycle phase or may be contained in any one phase. (AFR 800-14, Volume II).

Computer Program Configuration Items - A computer program or aggregate of related computer programs designated for configuration management. A CPCI may be a punched deck of cards, paper or magnetic tape or other media containing a sequence of instructions and data in a form suitable for insertion in a digital computer.

Configuration Item - An aggregation which satisfies an end use function and is designated for configuration management.

Configuration Management - A management discipline applying technical and administrative direction and surveillance to:

a. Identify and document the functional and physical characteristics of a configuration item;

b. Control changes to those characteristics; and

c. Record and report change processing and implementation status.

Control Software - Software used during execution of a test program which controls the nontesting operations of the ATE. This software is used to execute a test procedure but does not contain any of the stimuli or measurement parameters used in testing a unit under test. Where test software and control software are combined in one inseparable program, that program will be treated as test software. (AFLC 66-37)

Data Base - A collection of program code, tables, constants, interface elements and other data essential to the operation of a computer program or software subsystem.

External Interface - Data passed between two or more computer programs or between a computer program and peripheral devices external to the computer in which the program resides. The data may

be in the form of an interrupt signal or may be a digital data stream either output from the computer or input into the computer for processing.

Internal Interfaces - Data passed between elements of a computer program and usually included in the computer program data base.

Logic Flow - A diagrammatic representation of the logic sequence for a computer program. Logic flows may take the form of the traditional flow charts or in some other form such as a program design language.

Organic - A term used to designate a task performed by the Air Force rather than a contractor.

Product Baseline - The final approved configuration identification. It identifies the as designed and functionally tested computer program configuration. It is defined by the Computer Program Product Specification.

Program Design Language - An English-like, specifcally formatted, textual language describing the control structure, logic structure, and general organization of a computer program. Essential features of a program design language are:

a. It is an English-like representation of a computer procedure that is easy to read and comprehend.

b. It is structured in the sense that it utilizes the structured programming control structures and indentation to show nested logic.

c. It uses full words or phases rather than the graphic symbols used in flow charts and decision tables.

Quality Assurance - A planned and systematic pattern of all software related actions necessary to provide adequate confidence that computer program configuration items or products conform to establish software technical requirements and that they achieve satisfactory performance.

Software - A combination of associated computer programs and computer data required to enable the computer equipment to perform computational or control functions.

Software Quality - The primary characteristic of software quality is that the software reflects the specification to which it is written but also that the software specifications themselves adequately address the system/mission requirements. Key attributes of software quality include: reliability, flexibility, traceability, testability, integrity, maintainability, and completeness. Quality software is: well-defined, well-documented, free of design deficiencies and coding errors, satisfies performance requirements, and has minimum life cycle cost.

Support Software - Auxiliary software used to aid in preparing, analyzing and maintaining other software. Support software is never used during the execution of a test program on a tester, although it may be resident either on-line or off-line. Included are assemblies, compilers, translators, loaders, design aids, test aids, etc. (AFLC 66-37)

System Engineering - The application of scientific and engineering efforts to transform an operational need or statement of deficiency into a description of systems requirements and a preferred system configuration that has been optimized from a life cycle viewpoint. The process has three principle elements: functional analysis, synthesis, and trade studies or cost-effectiveness optimization.

System Generation - The process of producing a computer program from two or more program elements such that the separate program elements will perform together as an integrated whole.

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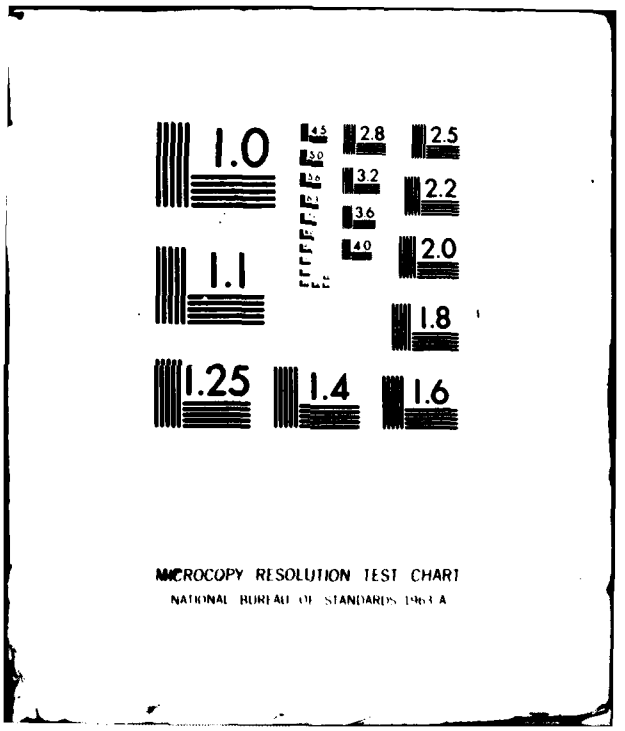
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Test Software - Programs which implement documented test requirements. There is a separate test program written for each distinct configuration of unit under test. (AFLC 66-37)

Top Down Integration - The development, testing and integration of the separate structural elements of a computer program in a hierarchical manner beginning with the highest levels and working down through the lowest levels until the computer program is complete.

Top Down Structured Programs - Structured programs with the additional characteristics of the source code being logically, but not necessarily physically, segmented in a hierarchical manner and only dependent on code already written. Control of execution between segments is restricted to transfer between vertically adjacent hierarchical segments.

Validation - Computer program validation is the test and evaluation of the complete computer program aimed at ensuring compliance with the performance and design criteria.

Verification - Computer program verification is the iterative process of continuously determining whether the product of each step of the computer program acquisition process fulfills all requirements levied by the previous step, including those set for quality.

System Life Cycle - The system acquisition life cycle consists of the following five major phases with major decision points:

a. Conceptual phase
b. Validation phase
c. Full-scale development phase
d. Production phase
e. Deployment phase

(AFR-800-14, Volume II)

Section 11.0 ABBREVIATIONS AND ACRONYMS

ADL	Approved Data List
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
AGE	Aerospace Ground Equipment
ASD	Aeronautical Systems Division
ATE	Automatic Test Equipment
ATLAS	Automatic Test Language for All Systems
BCD	Binary Coded Decimal
CCP	Contract Change Proposal
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CI	Configuration Items
CMP	Configuration Management Plan
CP	Computer Program
CPCI	Computer Program Configuration Items
CPDP	Computer Program Development Plan
CRISP	Computer Resources Integrated Support Plan
CRT	Cathode Ray Tube
CRWG	Computer Resources Working Group
DCN	Document Change Notice
DCP	Development Concept Paper
DEV	Development
DID	Data Item Description
DOC	Document
DOD	Department of Defense
DSARC	Defense System Acquisition Review Council
ECP	Engineering Change Proposal
ESD	Electronic Systems Division
FCA	Functional Configuration Audit
FORTRAN	Formula Translation
HIPO	Hierarchical Input Processing Output
HOL	Higher Order Language
HQ	Headquarters
IFPP	Information for Proposal Preparation
ILS	Integrated Logistics Support
ILSO	Integrated Logistics Support Office
ILSP	Integrated Logistics Support Plan
I/O	Input/Output
ISP	Integrated Support Plan
ITA	Interface Test Adapter
LRU	Line Replaceable Unit
ORLA	Optimum Repair Level Analysis
PCA	Physical Configuration Audit
PDL	Program Design Language
PDR	Preliminary Design Review
PMD	Program Management Directive

PMP	Program Management Plan
PRELIM	Preliminary
RFP	Request for Proposal
ROC	Required Operational Capability
SAE	Software Acquisition Engineering
SAMSO	Space and Missile Systems Organization
SCN	Specification Change Notice
SEP	Support Equipment Plan
SERD	Support Equipment Recommendation Data
SFE	Standard for Evaluation
SOW	Statement of Work
SPEC	Specification
SPO	System Program Office
SW	Software
SYS	System
TDSP	Top Down Structured Programming
T.E.	Training Equipment
TECPD	Training Equipment Computer Program Documentation
T.O.	Technical Order
TRD	Test Requirements Document
TS	Trainer Simulator
UUT	Unit Under Test
USAF	United States Air Force
VDD	Version Description Document
WBS	Work Breakdown Structure
WS	Weapon System

Section 12.0 COMPUTER PROGRAM DOCUMENTATION REQUIREMENTS INDEX

*U.S.Government Printing Office: 1980 — 657-064/538